NRCB | Natural Resources Conservation Board

BOARD DECISION NR 2010-01

NRCB Application No. 0601

Hammerstone Corporation
Hammerstone Quarry Project in the
Fort McMurray area

June 2010

TABLE OF CONTENTS

SECTION 1: INTRODUCTION 1
1.1: Application to the NRCB 1
1.2: Project Description and Scope of Review 2
1.3: Review Process 4
1.4: Public Consultation 5

SECTION 2: PROJECT NEED AND JUSTIFICATION 7
2.1: Project Need 7
    2.1.1: Views of the Applicant 7
    2.1.2: Views of the Panel 7

SECTION 3: ENVIRONMENTAL ISSUES 9
3.1: Air Quality 9
    3.1.1: Views of the Applicant 9
    3.1.2: Views of the Panel 14
3.2: Human Health 16
    3.2.1: Views of the Applicant 16
        3.2.1.1: Human Health Risk Assessment Methodology 16
        3.2.1.2: Results of the HHRA 18
    3.2.2: Views of the Panel 22
3.3: Noise 23
    3.3.1: Views of the Applicant 23
    3.3.2: Views of the Panel 24
3.4: Groundwater 26
    3.4.1: Views of the Applicant 26
    3.4.2: Views of the Panel 33
3.5: Surface Water 36
    3.5.1: Hydrology 36
        3.5.1.1: Views of the Applicant 36
        3.5.1.2: Views of the Panel 39
    3.5.2: Surface Water Quality 41
        3.5.2.1: Views of the Applicant 41
        3.5.2.2: Views of the Panel 46

3.6: Soils, Vegetation and Wetlands....48
  3.6.1: Soils....48
    3.6.1.1: Views of the Applicant....48
    3.6.1.2: Views of the Panel....53
  3.6.2: Vegetation and Wetlands....55
    3.6.2.1: Views of the Applicant....55
    3.6.2.2: Views of the Panel....60
3.7: Wildlife and Fisheries....63
  3.7.1: Wildlife....63
    3.7.1.1: Views of the Applicant....63
    3.7.1.2: Views of the Panel....67
  3.7.2: Fisheries and Aquatic Resources....69
    3.7.2.1: Views of the Applicant....69
    3.7.2.2: Views of the Panel....72

SECTION 4: RECLAMATION....75
4.1: Views of the Applicant....75
  4.1.1: Constructed Landform....75
    4.1.1.1: Landform Rationale & Design....75
    4.1.1.2: Landform Materials....76
    4.1.1.3: Risk review....78
  4.1.2: Quarry Lake....79
    4.1.2.1: Quarry Lake Design....79
    4.1.2.2: Quarry Lake Water Quality....80
  4.1.3: Conservation of Soil Resources for Reclamation....81
4.2: Views of the Panel....81

SECTION 5: LAND AND RESOURCE USE....85
5.1: Views of the Applicant....85
5.2: Views of the Panel....87

SECTION 6: TRADITIONAL RESOURCE USE AND ECOLOGICAL KNOWLEDGE....89
6.1: Views of the Applicant....89
6.2: Views of the Panel....91

SECTION 7: SOCIO-ECONOMIC ISSUES....93
7.1: Views of the Applicant....93
7.2: Views of the Panel....96

SECTION 8: HISTORICAL RESOURCES **97**
8.1: Views of the Applicant 97
8.2: Views of the Panel 100

SECTION 9: PANEL DECISION **101**
9.1: Decision 101
9.2: Overview 101
9.3: Rationale 102

APPENDIX A: NRCB FORM OF APPROVAL **105**
APPENDIX B: ACRONYMS AND ABBREVIATIONS **109**

SECTION 1: INTRODUCTION

1.1: Application to the NRCB

The *Natural Resources Conservation Board Act* (*NRCBA*) requires a review of a project to construct a mine or quarry to recover any metallic or industrial mineral as defined in the *Mines and Minerals Act,* for which an environmental impact assessment (EIA) report has been ordered. Birch Mountain Resources Ltd. was required to prepare an EIA under the mandatory EIA provisions (both the quarry and quicklime plant are mandatory activities) established by the Alberta *Environmental Protection and Enhancement Act*. On the recommendation of the Minister of Environment, the Lieutenant Governor in Council prescribed (O.C. 171/2005) the quicklime plant proposed by Birch Mountain Resources Ltd. as a reviewable project within the meaning of the *NRCBA*.

Birch Mountain Resources Ltd. filed an application with the Natural Resources Conservation Board (NRCB or Board) on May 24, 2006, for approval to construct the Hammerstone project (the Project) consisting of an integrated:

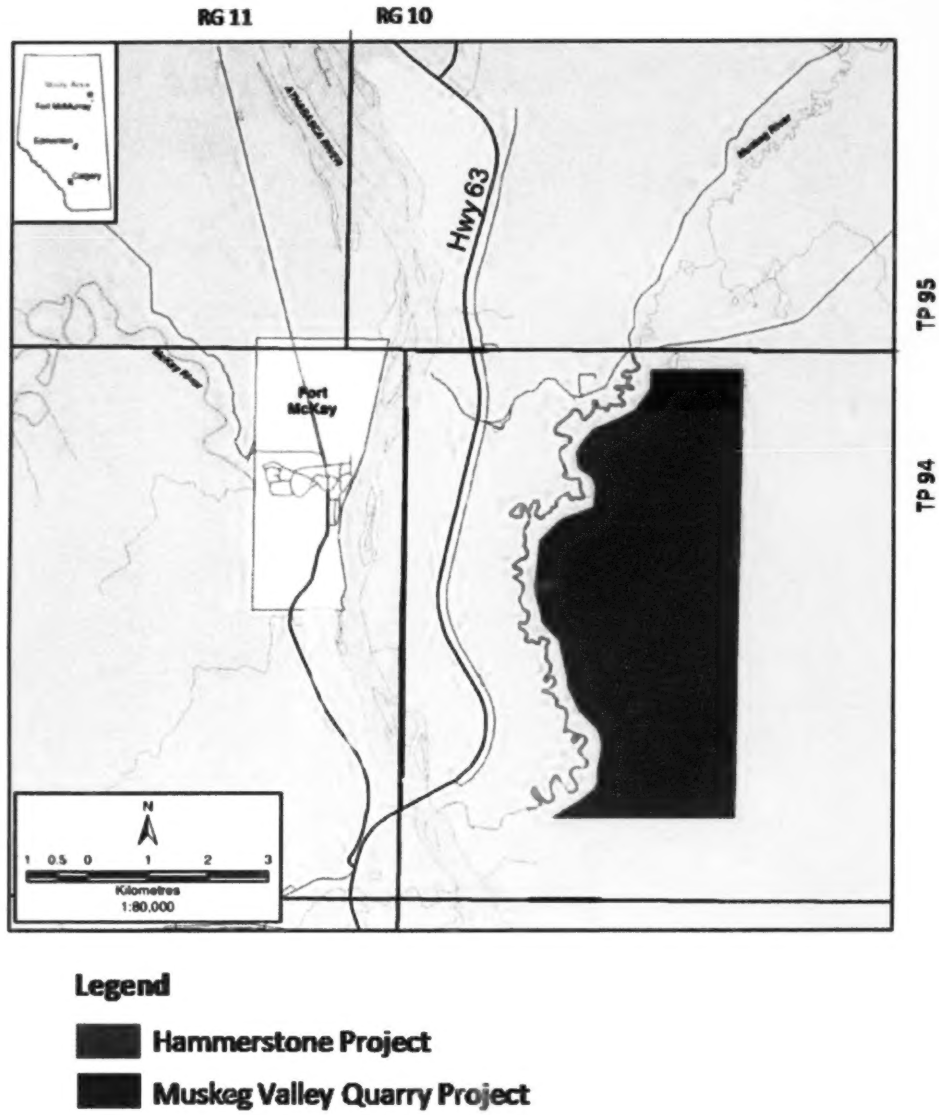
- limestone quarry;
- aggregate, reagent limestone, quicklime and cement production facilities;
- spent lime reprocessing; and,
- flue gas desulphurization (FGD) solids incorporation in the reclamation scheme.

The Hammerstone project is located approximately 60 km north of Fort McMurray and 6 km east of Fort McKay, Alberta (see Figure 1). On April 3, 2009 the Board was advised that Hammerstone Corporation (Hammerstone or the Applicant) had acquired the assets of Birch Mountain Resources Ltd. and would be proceeding with the application for the Hammerstone project.

The *NRCBA* enables an impartial public process to review projects that will or may affect the natural resources of Alberta. After having regard for the social and economic effects of a project and the effect of a project on the environment, the Board must determine whether, in its opinion, the project is in the public interest. A reviewable project cannot commence unless the NRCB has granted an approval. Section 9 of the *NRCBA* provides that the Board may grant an approval containing any terms and conditions that it considers appropriate. The rationale for any terms or conditions is to be set out clearly in the Board's decision. A review under the *NRCBA* differs from many statutory regulatory schemes in that the Board does not have an ongoing role in the regulation of the project or industry. As a result, the ongoing review and enforcement of conditions included in an *NRCBA* approval is normally delegated to a provincial department that has an ongoing regulatory function. The Board is careful to identify the appropriate delegate, most commonly Alberta Environment, to oversee the successful implementation of those conditions.

The NRCB established a division of the Board (the Panel) consisting of Vern Hartwell (Chair), Jim Turner and Donna Tingley to consider the application.

Figure 1: Project Location


RG 11
RG 10
Study Area
Fort McMurray
Edmonton
Calgary
Athabasca River
Hwy 63
Muskeg River
MacKay River
Fort McKay
TP 95
TP 94
N
1 0.5 0 1 2 3
Kilometres
1:80,000
Legend
Hammerstone Project
Muskeg Valley Quarry Project

1.2: Project Description and Scope of Review

The Board has reviewed the application to conduct mining and limestone processing activities on the associated Metallic and Industrial Mineral Leases and is satisfied that the application materials provide sufficient information to assess the environmental, social and economic effects from the described activities. The Hammerstone project is located immediately adjacent to the existing Muskeg Valley Quarry (MVQ) that is also owned and operated by Hammerstone Corporation. The NRCB issued Approval NR-2005-1 for the Muskeg Valley Quarry in July 2005.

The Hammerstone Project will extend Hammerstone's currently operating Muskeg Valley Quarry in the Regional Municipality of Wood Buffalo. Hammerstone proposes to operate the Project and the MVQ as a single integrated quarry and aggregate production operation. The combined quarry operation will disturb 1,265 hectares, of which 1,010 hectares is attributed to the Hammerstone Project. Quarry operations are anticipated to average limestone product sales of 7,444,112 tonnes/year in the first 5 years of integrated operation, escalating to 24,415,028 tonnes/year of average sales over the final 10 years of operation. Mining operations are expected to conclude in 2060.

The limestone processing facilities applied for as part of this application will be located within the footprint of the MVQ. Limestone processing facilities included in the application will produce aggregate, reagent limestone, quicklime and cement. Limestone aggregate is primarily used in road construction and maintenance. Reagent limestone is used by oilsands operations in the desulphurization of flue gas. Quicklime kilns will produce quicklime, milk of lime and hydrated lime. Quicklime is used in emission control systems to remove sulphur dioxide and sulphur trioxide in bitumen upgrader plants and in the water purification systems of many municipal and industrial facilities. Hydrated lime is required in the production of boiler feed water at the *in situ* oil sands projects. Cement production at the site will provide a local source for cement that will compete with the current cement production sites in Alberta located in Edmonton and Exshaw.

Hammerstone will also construct a recalcining system to process the by-product spent lime created from oil sands operations in the region. Hammerstone stated that this process "*represents an innovative means of reducing the amount of material being sent to sumps and landfills in the region.*"

The list of components and construction schedule for the limestone processing facilities as provided by Hammerstone in October 2009 is shown in the following table:

Table 1: Components and Construction Schedule for the Limestone Processing Facilities (Hammerstone Project Update, October 2009)

Component	Capacity (tonnes/day)	Products	Schedule		Cost (million)
			Construction	Commercial Operation	
Activation-1	2400	Activated limestone	2016	2017	$101
Quicklime-1*	600	Activated limestone and Quicklime	2014	2014	$116
Quicklime-2	600	Quicklime	2014	2015	$101
Quicklime-3	1,800	Quicklime	2018	2019	$148
PFC-1	240	Quicklime and recalcined	2011	2012	$33
PFC-2	360	Quicklime and recalcined	2012	2013	$41
Cement-1**	1,500	Cement	2020	2020	$197
				Total	**$737**

* Quicklime-1 may be operated in activation mode, or in quicklime mode.
** Cement-1 will have an initial capacity of 1,000 t/d. Capacity will be increased to 1,500 t/d following debottlenecking in about 2022.

Hammerstone indicated that a project impact assessment was conducted to provide a detailed, quantitative assessment of the Project development within the study areas that were defined for each component in the EIA. The Applicant stated that an assessment was conducted for both peak Project and residual impacts. According to Hammerstone, peak

Project impacts represent a worst-case scenario since all Project components are assumed to be developed and operating at one time. The Applicant indicated that residual impacts are those that remain after reclamation of the Project has been completed.

In addition to the Project assessment, Hammerstone conducted a cumulative effects assessment to examine the incremental effects of the Project on the regional environment. In conducting the cumulative effects assessment, Hammerstone assumed the Project was at full development and all projects publicly disclosed by January 2006 were constructed and made operational at the same time. The Applicant indicated that a reclamation scenario was not created for use in a cumulative effects assessment because not enough was known about the nature of land disturbances in the area or reclamation plans for other projects in the area.

Hammerstone indicated that the Project footprint was superimposed on a baseline scenario (determined from a local and regional baseline assessment) and an assessment of impacts on receptors within each environmental component was conducted. The Applicant indicated that the assessment was characterized according to criteria of magnitude, reversibility, geographic extent, and duration. Hammerstone stated that receptors were selected within each component of the EIA based on regulatory requirements, outcomes of multi-stakeholder sessions and stakeholder feedback.

1.3: Review Process

The Hammerstone Project application was filed with the NRCB on May 24, 2006. The NRCB and Alberta Energy and Utilities Board (now the Energy Resources Conservation Board) issued a Joint Notice of Filing on June 22, 2006. A copy of this Notice was published on July 3, 2006 in the Fort McMurray Today and in the July issue of Alberta Sweetgrass. Following independent reviews of the filed materials by the NRCB, the Energy Resources Conservation Board (ERCB) and Alberta Environment (AENV), consolidated requests for supplemental information were sent to the Applicant on July 6, 2007 and March 25, 2008. The information requested was determined necessary to complete the statutory mandates of the NRCB, the Energy Resources Conservation Board and Alberta Environment. The Applicant filed responses to the requested information in December 2007 and March 2008, thereby completing its application to the Board.

The NRCB received objections from the Mikisew Cree First Nation and the Métis Nation of Alberta – Local 1935 in response to an NRCB/ERCB Joint Notice of Application dated June 2, 2008. Birch Mountain Resources Ltd. requested that the Board extend it some time to continue discussions with the parties filing objections as it believed that it could address their concerns without the need for a hearing. At the same time as this was taking place there were a number of media articles in the major daily Alberta newspapers describing various financial challenges facing Birch Mountain Resources Ltd. Birch Mountain Resources Ltd. was placed in receivership on November 5, 2008. Following notification that Hammerstone Corporation was in the process of concluding a purchase of the Birch Mountain Resources Ltd. assets from the court appointed receiver, the Board suspended consideration of the Hammerstone Project application and advised the new owners of certain information that would be needed in order to lift the suspension. The Board was advised that Hammerstone Corporation had concluded a purchase of the Birch Mountain Resources Ltd. assets on April 2, 2009.

Hammerstone Corporation completed the Board's information requirements in December 2009. After consulting with Alberta Environment concerning the completeness of the EIA and completing its own review, the NRCB and Energy Resources Conservation Board issued a Joint Notice of Application dated December 14, 2009 that was published in the Edmonton Journal, Fort McMurray Today and Alberta Sweetgrass newspapers. The Board received two statements of concern in response to the Notice. The NRCB found that the persons filing the statements of concern failed to establish that they would be directly affected by the Hammerstone Project, and that the review of this project could be completed without the need for a public hearing. During its consideration of the application, the Board requested additional information which was provided by Hammerstone Corporation in April and May, 2010.

The Panel conducted a site tour related to the Project on May 5, 2010. The NRCB's general practice is that site tours are conducted with the full knowledge of all parties participating in the review. In the event a hearing is held as part of the review the Panel will notify all participants in advance and seek their input on the tour itinerary. As no hearing was held in conjunction with this review, the Panel notified Hammerstone in advance of its intention to conduct a site tour, but declined the offer to tour the actual mine site. The Panel was accompanied by a single NRCB staff member and remained on public roadways and public lands at all times. The site tour included travel north on Highway 63 from Fort McMurray to Fort McKay where the Panel stopped briefly at the Athabasca River in the town site. The Panel then continued to the entrance to the Muskeg Valley Quarry. The Panel conducted a walking site tour of the Quarry of the Ancestors. Before returning to Fort McMurray, the Panel travelled north to the entrance gates to the Syncrude (Aurora) and Petro Canada (Fort Hills) mines and east to Suncor (Firebag).

1.4: Public Consultation

Birch Mountain Resources Ltd. initiated its consultation process on the Hammerstone Project with the issuance of public disclosure documents in December 2004. Consultation involved a continuance of the relationship established between the Applicant and various community stakeholders that was initially established through the development of Birch Mountain's Muskeg Valley Quarry. Identified parties included the Fort McKay First Nation, Mikisew Cree First Nation, Athabasca Chipewyan First Nation, the Regional Municipality of Wood Buffalo Regional Issues Working Group and various individuals and corporations.

Up to the point in time that Birch Mountain Resources Ltd. was placed in receivership, the communications and consultation program was conducted primarily by a senior company official who was also a member of the company's Board of Directors. Quarterly consultation reports were prepared and included in the application filed with the Board in May 2006. Consultation efforts included meetings, picnics, technical workshops, site tours, and presentations with the Aboriginal communities, regulators, the public, stakeholders, industry associations and other interested groups at various locations within the region.

Following the asset acquisition by Hammerstone Corporation, the Board asked that the new owner provide an update on efforts to consult with stakeholders. In June 2009, Hammerstone Corporation provided a consultation log identifying contacts and communication with various Aboriginal communities and organizations.

A critical element of ensuring public awareness is the public consultation program conducted by the proponent. The Board is satisfied that Hammerstone Corporation (as a continuation of the efforts of Birch Mountain Resources Ltd.) conducted an adequate consultation process with all potentially affected parties. Hammerstone Corporation also committed to conduct ongoing consultation should it receive an approval.

SECTION 2: PROJECT NEED AND JUSTIFICATION

2.1: Project Need

2.1.1: Views of the Applicant

The Applicant stated that the Project would address critical resource shortages for aggregate, reagent limestone, quicklime and cement in the oil sands region and would contribute to the resolution of environmental concerns regarding the gypsum and spent lime by-products generated from flue gas desulphurization, fluidized bed combustion, and water treatment processes at regional oil sands operations.

The Applicant cited member company surveys conducted by the Regional Issues Working Group (RIWG) in stating that there is an acute and growing shortage of construction aggregate in the region needed to sustain projected construction in the region. The Applicant further submitted that there is a rapidly growing market for reagent products to mitigate sulphur emissions from current and planned oil sands facilities.

The Applicant also advised that there is a market opportunity for reagent limestone and quicklime to mitigate sulphur emissions from current and planned oil sands facilities as operators examine alternate fuels to natural gas. For the oil sands industry to utilize alternative fuels such as coke, coal or bitumen that contain sulphur, it is necessary to have a reliable source of reagent products to scrub the emissions or bind the sulphur in fluidized bed boilers. The Hammerstone project would provide a local supply of hydrated lime that would be used by many in-situ operations to treat produced water to recycle as boiler feed.

Hammerstone stated that the use of reagents to remove sulphur or lime to treat water generates by-products that result in handling and storage problems for many oil sands operators. Hammerstone proposed to return these by-products to its site for reprocessing and reuse in the case of spent lime and the incorporation of gypsum into the quarry as the base for terrestrial landform in the final reclamation of the Project.

2.1.2: Views of the Panel

The Panel accepts that there is a need for aggregate, reagent limestone, quicklime and cement in the oil sands region of the province. The Board expects that bitumen resource extraction and upgrading activities will experience continued growth for the foreseeable future, creating a growing demand for aggregate and limestone products in the region. The Panel accepts the fundamental importance of oil sands production to the provincial economy and consequently believes that the greatest justification for this development is the Project's role in meeting future demand associated with the present and anticipated pressure on the regional economy brought by oil sands development.

SECTION 3: ENVIRONMENTAL ISSUES

3.1: Air Quality

3.1.1: Views of the Applicant

The Applicant indicated that air emissions would be generated from the combustion of coke, trace bitumen and natural gas and from the quarry vehicle fleet (through diesel combustion).

According to the Applicant, the contaminants of potential concern would include carbon monoxide (CO), hydrogen sulphide (H_2S), nitrogen oxides (NO_x), particulate matter less than 2.5 µm ($PM_{2.5}$), particulate matter less than 10 µm (PM_{10}) and sulphur dioxide (SO_2). In addition to the aforementioned contaminants, approximately thirty chemicals of potential concern were selected for inclusion in the air quality analysis in order to support the updated Human Health Risk Assessment. These chemicals included metals, volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). The Applicant also indicated that it was not yet clear as to its reporting requirements under the National Pollutant Release Inventory; however, it identified a list of the potential Project emissions requiring reporting, which included a number of PAHs and total dioxins and furans.

Hammerstone indicated that the air quality local study area (AQLSA) was a 5 km by 10 km rectangle centred on the Project site. It also indicated that the air quality regional study area (AQRSA) had a north-south extent of about 350 km and an east-west extent of 200 km.

Hammerstone stated that the baseline case included existing and approved projects in the AQRSA. The Project case included existing, approved projects and the Hammerstone Project in the AQRSA. The cumulative effects assessment (CEA) case included the Project plus proposed projects in the AQRSA.

The Applicant indicated that the following measures would be taken to reduce air emissions from the Project and have been accounted for in the air dispersion modeling:

- The amount of movement and manipulation of source rock and product would be minimized, thereby reducing vehicle emissions and dust generation. This would be accomplished by the use of semi-mobile aggregate processing systems to keep pace with the moving faces of the quarry. Conveyor systems would transfer crushed limestone for sale and for processing.
- The access road into the Project as well as some of the roads within the quarry would be paved and other roads within the quarry area would be surfaced with relatively coarse, competent limestone aggregate. Vehicle traffic would be reduced by employing a transportation system for the workers that reside in the local communities. The roads would be watered for dust suppression.
- Particulate emissions from the plants would be controlled using fabric filters in baghouses.

- SO_2 emissions would be captured by the gypsum ($CaSO_4$) formed within the rotary lime kilns and also by a dry lime scrubber, resulting in an overall capture efficiency of 90 percent.
- The activation kiln would be equipped with a dry lime scrubber for the treatment of flue gases resulting in a 70 percent SO_2 capture efficiency.
- SO_2 emissions would be captured within the cement product (clinker) within the kiln and also by the finely ground limestone in the raw feed roller mill, with the overall capture efficiency estimated as 90 percent (with no further flue gas treatment proposed).
- SO_2 emissions would be captured by the gypsum formed in the pneumatic flash calciner (PFC), resulting in a capture efficiency of 90 percent.
- NO_x emissions would be controlled through the use of low NO_x burner systems in the rotary kilns. The PFC would have a low temperature flame profile and would be inherently a low NO_x device.
- The Applicant committed to the use of best available technology economically achievable (BATEA) principles to control air emissions at the time that the detailed design of the plants would be initiated.
- VOC emissions would be controlled by ensuring that process conditions are maintained in a manner to combust over 99 percent of the VOCs produced or of the VOCs used as a fuel.
- The blasting technique currently used at the Muskeg Valley Quarry (MVQ), which would also be used in the Hammerstone quarry, is not conventional. Minimal amounts of explosives relative to the amount of quarried limestone would be used to preclude the generation of large dust plumes typically associated with conventional blasting. Furthermore, blasting would occur at a maximum frequency of once per day.

The Applicant employed the following approach and data sources in the prediction of ground level concentrations of the identified emissions:

- Emissions of NO_x, CO, and VOCs from the Project (mobile equipment, stationary diesel engines, electric generators) were calculated by scaling up estimates from similar operations at the MVQ by 4.3 times (as the production would be 4.3 times greater).
- Particulate matter emissions from transport-related sources of the Project were estimated based on the design road characteristics, haul lengths and traffic estimates of the Project. In-quarry SO_2 emissions were scaled directly from MVQ emission estimates and adjusted to reflect the anticipated reduction in the sulphur content of diesel fuel.
- Processing plant emissions from plant combustion sources were estimated based on derived fuel gas consumption.
- The effects of blasting were excluded from the emission estimates.
- The CALPUFF dispersion model with the Industrial Source Complex Model (ISC) terrain adjustment scheme was used to model ambient concentrations.

- The receptor grid spacing was set from 50 m to 10 km with a more dense receptor grid spacing established near the Project emission sources. Receptors were also placed 20 m apart along the northern portion of the Project boundary line with a total of 4,214 receptor locations modeled.
- When reporting maximum concentrations, predictions within developed areas (maximum footprints) were ignored; this is an approach that is consistent with other recent assessments in the area.
- Predictions of potential acid input (PAI) were also made using CALPUFF. Critical, target and monitoring loads for management of acid deposition in Alberta were established on the basis of the work of the Clean Air Strategic Alliance (CASA) Target Loading Subgroup.
- NO_2 results were predicted using the Ambient Ratio Method outlined in the Alberta Environment *Air Quality Model Guideline* (2003).
- The CALMET model was used to generate three-dimensional wind, temperature and turbulence data fields for use by the CALPUFF model. The Applicant stated that winds at the Project site would be predominantly from the west.
- The Applicant modeled ambient air concentrations for predicted hourly, maximum 24-hour and annual average concentrations.
- Differences of less than 10 percent in air quality assessment results between baseline and application cases were considered to indicate a low impact as a result of the Project.

Hammerstone provided Table 2 that illustrated the predicted increase in emissions that would occur as a result of the Project and in the CEA case. The Applicant observed that the increases in emissions as a result of the Project relative to baseline were minimal.

Table 2: Comparison of Baseline, Hammerstone and CEA Emissions (Table P3.8, Supplemental Information Response, Preamble, July 2007)

Scenario	**SO_2 (t/d)**	**NO_x (t/d)**	**CO (t/d)**	**$PM_{2.5}$ (t/d)**	**Total VOC (t/d)**	**PM_{10} (t/d)**
Baseline (t/d)	205.62	332.90	302.42	25.04	410.93	28.59
Hammerstone Project (t/d)	9.46	12.79	11.79	1.12	2.62	2.48
Application (t/d)	215.09	345.69	314.21	26.16	413.55	31.07
Application Increase Relative to Baseline (%)	*4.6*	*3.8*	*3.9*	*4.5*	*0.6*	*8.7*
CEA (t/d)	237.60	503.45	473.63	38.48	708.25	44.93
CEA Increase Relative to Baseline (%)	*16*	*51*	*57*	*54*	*72*	*57*

The Applicant reported that for SO_2, NO_x, CO, VOCs, PAHs and metals there were no exceedances of Alberta Ambient Air Quality Objectives (AAAQO) at any of the receptors for any of the cases. However, Hammerstone indicated that benzene (which is a VOC) approached the AAAQO at the maximum ground level concentration for all cases. Hammerstone stated that the primary source responsible for the maximum ground level concentration for benzene is the Syncrude Mildred Lake Settling Basin. The Applicant observed that there is no difference in concentrations between the baseline and application cases for benzene.

The Applicant reported that the Canada Wide Standard for $PM_{2.5}$ was predicted to be exceeded at the regional maximum ground level concentration, but would not be exceeded at any communities in the region (Fort Chipewyan, Fort McKay, Fort McMurray and Anzac) in the baseline and application cases. The maximum ground level concentration for $PM_{2.5}$ was predicted by the Applicant to be in the vicinity of the Horizon mine for baseline and application cases and the maximum for the CEA case was located in the vicinity of Highway 63 and the Syncrude facility. Table 3 from the Environmental Impact Assessment (EIA) contains the predicted $PM_{2.5}$ concentrations for the baseline, application and CEA cases.

Table 3: Predicted Particulate Matter Concentrations in the AQRSA (Excerpt from Table P3.11, Supplemental Information Response, Preamble, July 2007)

Receptor Location	**98th Percentile 24-hour $PM_{2.5}$**		
	Baseline ($\mu g/m^3$)	**Application ($\mu g/m^3$)**	**CEA ($\mu g/m^3$)**
Overall Maximum ground level concentration	65	65	80
Fort Chipewyan*	7.0	7.1	18
Fort McKay*	16	17	27
Fort McMurray*	<30	<30	>60
PTI Lodge	21	27	35
Trappers Cabin	17	26	33
Remote Camp	21	28	35
Shell – east lease boundary	18	23	36
Notes: Exceedance of AAAQO of 30 $\mu g/m^3$ *Communities			

Hammerstone noted that there are no Alberta ambient air quality objectives for PM_{10}, therefore the British Columbia interim objective was used. The Applicant reported that the British Columbia objective for PM_{10} was predicted to be exceeded at the regional maximum ground level concentration but would not be exceeded at any communities in the region in the baseline and application cases. Maximum PM_{10} concentrations were predicted by the Applicant in the vicinity of the Albian Sands Muskeg River mine for baseline and application and in the vicinity of the expanded Suncor operation in the CEA case. According to Hammerstone, the MVQ and Hammerstone Projects were the only facilities for which fugitive dust emissions were estimated in the modeling. For all other operations, only combustion emissions were considered. For the CEA case, traffic emissions on Highway 63 were assumed by the Applicant to increase at 3 percent per year until 2040 which is the year in which CEA air quality impacts were determined.

The Applicant reported that the total suspended particulate (TSP) emissions for all facilities were assumed to be equal to PM_{10} emissions, with the exception of the MVQ and Hammerstone Projects which were calculated specifically. The maximum ground level concentrations of TSP predicted by Hammerstone exceeded the AAAQO for all assessment cases but would not be exceeded at any of the communities.

To address the predicted particulate concentration exceedances, Hammerstone noted that none of the exceedances were predicted in the application case at any of the communities or at the closest settlements (cabins, camps) and moreover, the exceedances that were predicted in the application case already existed in the baseline case. As such, the Applicant contended that the Project would not result in any exceedances at new locations. Hammerstone indicated that PM_{10} and TSP emissions would be amenable to dust mitigation procedures and committed to reviewing dust control methodology.

The CALPUFF model results were used by Hammerstone to predict that the Project would increase the area within the AQRSA above the acid deposition monitoring load area by 4.7 percent (27 kha) and would increase the area above the critical load area by 4.0 percent (16 kha). As such, the Applicant considered the Project contribution to acid deposition as low. It also noted that the Alberta acid deposition monitoring framework specifies that an exceedance of a target load at a local scale (e.g., Project EIA) is not to be considered an exceedance of an environmental objective. According to Hammerstone, the CEA emissions were predicted to be about 59 percent (343 kha) and 70 percent (282 kha) above the baseline case in the AQRSA within the monitoring and critical load thresholds, respectively. Hammerstone committed to monitor the potential effects of acidifying emissions through its participation in Wood Buffalo Environmental Association (WBEA) monitoring programs.

The CALPUFF model results were used by the Applicant to predict that the Project would increase the area within the AQRSA above the 5 kg/ha/yr nitrogen deposition threshold by 2.5 percent (7 kha) and an approximate 9 percent (10 and 3 kha) increase in the areas above the 10 and 15 kg/ha/yr thresholds, which it considered to be a low to moderate Project contribution. According to Hammerstone, the CEA emissions resulted in an increase of about 64 percent (194 kha), 85 percent (100 kha) and 120 percent (47 kha) above the 5, 10 and 15 kg/ha/yr thresholds, respectively.

The Applicant reported that the estimated Project contribution to maximum ozone concentration was about 0.6 percent in the application case, which it considered low. Hammerstone indicated that it would support a review of ozone levels in the region that is planned for 2011. Should the 2011 review indicate a requirement to respond to elevated ozone levels, Hammerstone committed to collaboratively identify appropriate management requirements with other Cumulative Effects Management Association (CEMA) stakeholders and evaluate potential technological or operating adjustments of the Project site that would contribute to reductions in ozone formation in the region. The Applicant also committed to support the regional monitoring network, including the WBEA Ozone monitoring program.

The Applicant conducted air quality monitoring from August 2008 to December 2009 at an air quality monitoring station constructed in 2008 at a location approximately 2 km to the south-southwest of the MVQ southern boundary. Hammerstone evaluated the data against the Canada Wide Standard for $PM_{2.5}$ as well as the new AAAQO which were published in 2008. Six days of instrument operation in 2008 were reported by the Applicant as having one-hour average $PM_{2.5}$ concentrations of 30 $\mu g/m^3$ or higher; however, there were no exceedances of the 24-hour average. Ten days of instrument operation in 2009 were reported by the Applicant as having one-hour average $PM_{2.5}$ concentrations of 30 $\mu g/m^3$; however, there were no exceedances of the 24-hour average. Hammerstone indicated that it was exploring submitting its results to the WBEA for possible incorporation into the regional air quality database.

The Applicant contended that participation in regional monitoring programs was a more robust means of monitoring than independent programs conducted by the various project operators. Hammerstone indicated that it expected to be a member of the CEMA and the WBEA in 2010, and is currently a member of the Oil Sands Developers Group (OSDG). It is active on the OSDG Environment Committee that oversees the CEMA and WBEA programs. It also indicated that to the extent that it is able, it would participate in the meetings and initiatives of these stakeholder groups.

The Applicant indicated that greenhouse gas (GHG) emissions from the Project would be released from the combustion of diesel, natural gas, coke and bitumen and from the off-gas of limestone and cement. The estimated project emissions represent 1.2 percent of the total annual Alberta GHG emissions (223 Mt CO_2E/yr) and 0.4 percent of the total annual Canada GHG emissions (726 Mt CO_2E/yr).

The Applicant committed to participate in industry and government research programs involved in the development of economical technologies for carbon dioxide (CO_2) capture and as technologies become available, it committed to engineer and install a technology platform upon which CO_2 capture could be accomplished. It further committed to allocate staff and, as appropriate, financial resources to the advancement of systems for gathering and exporting CO_2 from the oil sands region.

3.1.2: Views of the Panel

The Panel finds that Hammerstone used the best available data and made the appropriate assumptions in a conservative manner in conducting air dispersion modeling used for determining the predicted ambient ground level concentrations as a result of air emissions from the Project. The Panel notes that the Applicant used the ambient ratio method to predict ambient NO_2 concentrations and finds that this is a method accepted by AENV for environmental assessments done in the Regional Municipality of Wood Buffalo.

The Panel agrees that the CALPUFF air dispersion model used to determine ambient concentrations is appropriate for the type of emissions that are expected to be generated from the Project and allows for predictions of PAI.

The Panel acknowledges that Hammerstone committed to implement a BATEA approach when making final decisions regarding technology that mitigates air emissions; as a condition of approval the Panel requires that BATEA principles be followed in final designs as each plant is brought online.

The Panel observes that the use of coke as the major source of fuel for the Project generates significantly more SO_2 emissions than if an alternate fuel source was used, and appreciates that if it is identified that regionally SO_2 emission reductions are required, that Hammerstone has options in further reducing its SO_2 emissions.

The Panel understands that the Applicant considered that increases in air quality assessment results of less than 10 percent as a result of the Project would have low impacts; however, the Panel finds this is an appropriate assessment tool only when predicted levels do not exceed AAAQO in the context of the *Keeping Clean Areas Clean* principle.

The Panel observes that ambient concentrations for benzene for the maximum ground level concentration approach the AAAQO. Since there were no differences between baseline and application cases, the Project has no predicted contribution.

The Panel observes that predicted ambient concentrations for $PM_{2.5}$ at the maximum ground level concentration exceed the AAAQO for the baseline and application cases and also have exceedances for the CEA case at a number of the nearby receptors. The Panel also observes that the Project shows a contribution to the predicted ambient concentrations as the concentrations at the nearby receptors are higher for the application case than the baseline case. The Panel appreciates that the predictions are made for the Project at full production and it would be some time before all the elements of the Project are in full operation. The Panel notes that Alberta has a framework for the management of $PM_{2.5}$ regionally, calling for action at different trigger levels. It appears that the Project may contribute to ambient $PM_{2.5}$ concentrations above the planning trigger level in the future, if regional emissions remain as predicted.

The Panel observes that there were also predicted exceedances of the British Columbia interim objective for PM_{10} and the AAAQO for TSP, and appreciates that the Applicant has committed to reviewing applicable dust control methodology.

The Panel is of the opinion that Hammerstone has a responsibility to contribute to regional solutions to air quality issues. The Panel considers any predicted exceedance of the AAAQO as a serious matter calling for action. Therefore, as a condition of approval the Panel requires the Applicant to actively contribute to regional processes addressing air quality issues, with the goal of achieving reductions in emissions. The Panel notes that Hammerstone is not yet a member of the CEMA or the WBEA and encourages participation in these specific organizations.

The Panel observes that the Project will contribute to acid deposition above critical loads in the AQRSA and appreciates that provincial frameworks do not consider this an exceedance of an environmental objective. However, the Panel finds that Hammerstone has a responsibility to demonstrate a commitment to improve upon the projected results regarding generation and release of acidifying emissions. As a condition of approval, the Panel requires the Applicant to actively participate in regional committees and associations that are working to understand the impacts of acidification and reduce PAI emissions, particularly in areas where critical loads have been exceeded.

The Panel observes that results from dispersion modeling are accurate only to the extent that assumptions made are correct and it acknowledges that monitoring is required to verify those results. Based on the air monitoring conducted by Hammerstone as required by the MVQ approval, the Panel observes that ambient $PM_{2.5}$ concentrations for that project appear to be in line with predictions, but finds it challenging to review results when only potential exceedances of the ambient objective are reported rather than increases in ambient concentrations above predictions. The Panel acknowledges that the Applicant is considering sharing its monitoring data with the WBEA and encourages it to do so. The Panel understands that AENV regularly asks for stack emission monitoring as a condition of approval of industrial facilities. As a condition of approval, the Panel requires that ambient air and stack emission monitoring be conducted in a manner satisfactory to Alberta Environment.

The Panel observes that the Project will make a substantial contribution to Alberta's total annual GHG emissions. It notes that Hammerstone will have a legislated requirement under the *Specified Gas Emitters Regulation* to reduce its emissions intensity over time.

The Panel concludes that the impacts of the air quality emissions from the Project are acceptable with the noted commitments from the Applicant and required conditions of this approval.

3.2: Human Health

3.2.1: Views of the Applicant

The Applicant conducted a Human Health Risk Assessment (HHRA) for the normal operational conditions of the Project. It stated that HHRA methodology used was based on protocols outlined by the Canadian Council of Ministers of the Environment (CCME), Health Canada and the United States Environmental Protection Agency (US EPA). The Applicant also reported that additional guidance on conducting the HHRA was provided by Alberta Health and Wellness.

3.2.1.1: Human Health Risk Assessment Methodology

Hammerstone employed the following four-step approach in conducting the HHRA:

1. Problem Formulation

   The chemicals of potential concern identified by the Applicant were the same as those indicated in the air quality assessment (Section 3.1.1). In addition, additive effects that were assessed included cardiovascular, dermal, developmental, gastrointestinal, hematopoietic, immunological, renal, hepatic, nervous, reproductive and respiratory endpoints.

   The Applicant indicated that the routes of exposure for the acute health risks were soil inhalation and air inhalation. The routes of exposure for the chronic health risks were soil ingestion, soil dermal, soil inhalation, water ingestion, air inhalation, vegetation ingestion, fish ingestion and meat ingestion. The Applicant attested that there were no potable uses of surface water or groundwater in the vicinity of the Project; this pathway was only considered for individuals that might be engaging in traditional activities in the air quality regional study area (AQRSA) that might be consuming water from the local surface water bodies.

The Applicant identified 18 receptor locations, the maximum ground level concentration and also the Project maximum ground level concentration (at the Project boundary).

2. Toxicity Assessment

The Applicant used the following information sources to determine the exposure limits for adverse human health effects: Agency for Toxic Substances and Disease Registry (ATSDR), California Environmental Protection Agency, Health Canada, Maine Center for Disease Control, Minnesota Department of Health, Michigan Department of Environmental Quality, New Jersey Department of Environmental Protection, Risk Assessment Information System, Texas Commission for Environmental Quality, US EPA Integrated Risk Information System (IRIS), National Institute for Public Health and the Environment (RIVM), US EPA Region 9, US EPA Region 3, Ontario Ministry of Environment, Oregon Department of Environmental Quality and the World Health Organization. In Hammerstone's opinion it used the most conservative exposure limits available in the HHRA except in two instances (total chromium, manganese) where Hammerstone provided a scientific explanation for the use of the appropriate exposure limit.

According to the Applicant, the toxicity assessment examined potential acute (short-term) and chronic (long-term) health risks associated with the identified chemicals of concern.

3. Exposure Assessment

The Applicant's exposure estimates were based on results of the air dispersion modeling (see Section 3.1). Baseline, application and cumulative effects assessment (CEA) cases used by the Applicant for assessing the effects of air contaminants on human health were the same as those referred to in the air quality section of its environmental impact assessment (EIA).

For determining chronic health risk, Hammerstone assumed that individuals would be at the receptor locations for the duration of their lives (75 years), and the worst case receptor would be First Nations members because of their higher consumption of country foods.

For the cancer risk assessment, the risks were assessed by the Applicant for the adult phase and also for a composite adult receptor that accounts for exposures during earlier life stages (i.e., infant, toddler, child, youth and adult).

4. Risk Characterization

The Applicant used Hazard Quotients (HQ) to characterize the risk from the chemicals of concern with:

$$HQ = \frac{\text{Exposure Point Concentration (or Estimated Daily Intake)}}{\text{Toxicological Reference Value}}$$

The Applicant interpreted the HQs as follows:

> $HQ \leq 1$ – signified that the estimated exposure is less than or equal to the exposure limit and no adverse health risks are predicted.
>
> $HQ > 1$ but ≤ 10 - it may have indicated some potential risk, but the significance of this risk must be re-evaluated in light of the degree of conservatism incorporated in the health risk assessment.
>
> $HQ > 10$ - indicated that there is an increased likelihood of potential health risks. Under such situations, risk management measures may need to be implemented to reduce the potential risks.

The Applicant expressed potential carcinogenic risks as incremental lifetime cancer risks (ILCRs). ILCRs refer to the predicted number of cancer cases per 100,000 people that could potentially result from exposure to carcinogens. An ILCR greater than 1×10^{-5} was considered by Hammerstone, Alberta Health and Alberta Environment to represent an unacceptable level of risk. ILCR was calculated by the following:

$$ILCR = \text{Exposure Point Concentration (or Estimated Daily Intake)} \times \text{Toxicological Reference Value}$$

The Applicant also conducted an assessment based on Health Canada's SUM25 and SUM15 methods. It looked at increased daily mortality and increased hospital admissions for cardio-respiratory causes associated with particulate matter less than 10 µm (PM_{10}) and particulate matter less than 2.5 µm ($PM_{2.5}$). The methods determined potential health risks when daily thresholds of PM_{10} concentrations exceeded 25 $\mu g/m^3$ and $PM_{2.5}$ concentrations exceeded 15 $\mu g/m^3$.

3.2.1.2: Results of the HHRA

The Applicant indicated that all predicted HQ values for the criteria air contaminants (NO_2, SO_2, $PM_{2.5}$, TSP and CO) were below one for the baseline, application and CEA cases and at all receptor locations with the following exceptions:

- Nitrogen dioxide (NO_2) (for annual concentration) had HQ values that marginally exceeded one for all three cases at multiple receptor locations. Hammerstone explained that its Project emission contributions were not responsible for the HQ values exceeding one at any of the receptor locations.

- $PM_{2.5}$ (for the 24 hour 98th percentile concentration) had HQ values that exceeded one (but were less than ten) for all three cases at multiple receptor locations. The Applicant reported that the Albian Mine receptor location was the only receptor location where the contribution of the Project emissions had increased the HQ value above one.
- TSP (total suspended particulate) (for the 24 hour maximum concentration) had HQ values that exceeded one (but were less than ten) for all three cases at multiple receptor locations. Hammerstone demonstrated that the contribution of Project emissions did not increase the HQ values above one at any of the receptor locations.

The Applicant reported that the results of the SUM25 and SUM15 methods showed that for most of the receptor locations, the Project risks were comparable to the baseline risks. Hammerstone indicated that there was a small incremental increase in mortality and hospital admissions present for most of the receptor locations; however, the PTI Lodge, Trappers Cabin, Remote Camp, Shell and CNRL receptor locations had higher increases.

Hammerstone concluded that the estimated increased risk associated with the Project in terms of the criteria contaminants, was generally either nonexistent or small in magnitude compared to baseline. The Applicant indicated that where there were increases in the Project risk estimates compared to the baseline. The risk estimates were not increased to levels above the acceptable criteria with the exception for the 24 hour 98th percentile $PM_{2.5}$ concentration at the Albian Mine receptor location where the HQ increased from one in the baseline to 1.1 in the Project. It explained that where the risk estimates were above the acceptable criteria, the exceedances were present in all three cases or were present only in the CEA case.

The Applicant indicated that all predicted HQ values for metals, polycyclic aromatic hydrocarbons (PAH) and volatile organic compounds (VOC) were below one, and all ILCR's for the amortized adult were less than 1×10^{-5}, for the baseline, application and CEA cases at all receptor locations, with the following exceptions:

- Arsenic had ILCR values greater than 1×10^{-5} for total combined pathways for all cases and all receptor locations (although the results were within the same magnitude). Hammerstone explained that the risk evaluation is not reliable due to the procedure used to account for the non-detectable concentrations of arsenic in the potable water produced by the Fort McMurray water treatment facility. Hammerstone concluded that even with the more conservative oral unit risk, the risks due to arsenic exposure in the region are overestimated and not likely to represent a real risk to human health.

- 7,12-dimethylbenz(a)anthracene had ILCR values exceeding 1×10^{-5} for vegetation ingestion, fish ingestion and total combined pathways at multiple locations for application and CEA cases. Hammerstone stated that for most locations, the exceedances were marginally higher than the criterion and that it is likely that reasonable maximum exposures would manifest risks at acceptable levels since the assessment was conservative in nature. The only exception to this was the overall maximum location where the exceedance was in the range of an order of magnitude. Hammerstone cautioned that the model is overly conservative and does not take into consideration the persistence of the chemical in the environment. It reported half-lives for 7,12-dimethylbenz(a)anthracene of 0.4 to 4 hours in the air, 1 to 6 years in water and 20 to 28 days in soil. Since the surface water concentration is dependent on the deposition of the chemical from the air onto the surface water and soil, the concentration in the surface water and hence the fish tissue may be overestimated. Therefore, although the model predicted risks due to the consumption of fish for 7,12-dimethylbenz(a)anthracene, the calculated risks were judged by the Applicant to be overestimates associated with the conservative approaches applied, and that the risk associated with 7,12-dimethylbenz(a)anthracene in the fish consumption pathway is negligible. Hammerstone also explained that the risk estimates for the baseline vegetation ingestion pathway might actually be similar to those for the Project as there was no baseline emission rate for 7,12-dimethylbenz(a)anthracene for the MVQ.
- The acute and chronic HQ values for acrolein exceeded one, but were less than ten for the overall maximum ground level concentration receptor location for all three cases and at additional receptor locations in the CEA case. Hammerstone explained that the primary contributor to the exceedances was the inhalation of acrolein vapours in the air and that there was little difference between the baseline and application cases.
- Benzene had ILCR values greater than 1×10^{-5} for water ingestion and total combined pathways for all cases at the overall maximum ground level concentration (although the results were within the same magnitude). Hammerstone explained that the exceedance existed for the baseline scenario, therefore the Project did not contribute to the overall carcinogenic risk for the lifetime receptor.
- The chronic HQ values for cobalt exceeded one, but were less than ten at all receptor locations for the application and CEA cases for the fish ingestion and total pathways. Hammerstone explained that the toxicological reference value was based on the incidence of cardiomyopathy following oral exposures of cobalt. However, the effect was observed in a small population of people, of which the effects of alcohol intake could be a confounding factor. Therefore, the cobalt risks might be overestimated due to the selection of a toxicological reference value that might not be appropriately derived (in the context of the Hammerstone Project). Hammerstone indicated that no other regulatory agency had derived a toxicological reference

value that could be used to validate or otherwise examine the results of this assessment. As such, Hammerstone attested that it is unlikely that adverse health effects would occur as a result of the Project.

- The chronic HQ values for total aldehydes exceeded one, but were less than ten for the total combined pathway and the air inhalation pathway, in all cases at multiple receptor locations. Hammerstone explained that the assessment was based on using acetaldehyde as a worst case surrogate to represent the entire group and would lead to an overestimation of the potential health risk as acetaldehyde accounts for only 0.7 percent of the total aldehyde emissions from the Project. Additionally, the Applicant explained that acetaldehyde and formaldehyde were also included as part of the aldehyde mixture leading to double counting of the potential risks since these chemicals were assessed separately. Based on these considerations, Hammerstone concluded that adverse health effects may not be likely following exposures to the various environmental media in the three cases.
- Total PAHs had ILCR values greater than 1×10^{-5} for total combined pathways for the CEA case only at the overall maximum ground level concentration (although the results were within the same magnitude). Hammerstone explained that fish ingestion was the primary contributor to the total ILCR risk at this receptor location. Although there is an exceedance of the criteria, it was for the CEA case only while the Application case remained less than the criteria. Based on this, the Applicant indicated that it is expected that PAH emissions from the Hammerstone Project would not result in adverse health effects.

Hammerstone reported that for additive effects, exceedances were noted in the following:

- Chronic HQ values for cardiovascular additive effects were greater than one, but less than ten for the fish ingestion pathway, in the application and CEA cases at all the receptor locations. Hammerstone explained that the risks were primarily a reflection of the exposure to cobalt, which it attributed to the use of an overly conservative toxicological reference value. The Applicant concluded that the consumption of fish was unlikely to cause cardiovascular effects that are attributable to the Hammerstone Project.
- Chronic HQ values for nervous and reproductive additive effects were greater than one, but less than ten for all cases at the overall maximum ground level concentration. Hammerstone explained that as the values were similar in all cases, the Project would not contribute significantly to the risks for these effects.
- Chronic and acute HQ values for respiratory additive effects were greater than one, at all cases and multiple receptor locations. In the CEA case the chronic HQ value exceeded ten at the overall maximum ground level concentration. The risk estimates for the Project differed

very little from the baseline case. It also indicated that given the degree of conservatism that was built into the assessment, and that the conservatism was further amplified in the additive effects approach, Hammerstone believed that the exceedance of ten indicated by an HQ of 14.9 represented no real potential for a negative health outcome, under the CEA case.

- Gastrointestinal additive effects had ILCR's greater than 1×10^{-5} for the application and CEA cases at the overall maximum ground level concentration. Hammerstone explained that the effects were based on conservative worst case assumptions and uncertainties regarding human and ecological receptor behaviour might actually be responsible for reducing the potential risks.
- Hematopoietic, nervous, and reproductive additive effects for the amortized adult had ILCR's greater than 1×10^{-5} for all cases at multiple receptor locations. Hammerstone explained that there was very little difference between the baseline and application cases, therefore the Project contribution to the overall risk for the development of these cancers would be considered minor.

The Applicant concluded that there were no identifiable risks of the Hammerstone Project on human health in the region due to the conservative assumptions made in the assessment including:

- Using maximum emission rates from the Project in the air dispersion modeling;
- Using worst-case local meteorological conditions as a basis for the air dispersion modeling; and,
- Using exposures based on continuous 24 hour, 365 days per year for the entire lifetime.

Hammerstone further concluded that the CEA case indicated that adverse health effects might be present in the AQRSA, but these effects were not a consequence of the Project since the increase in the risk above the baseline level could not be attributed to the Project.

3.2.2: Views of the Panel

The Panel finds that Hammerstone used the best available exposure limits in the HHRA. The Panel is aware that Alberta Health participated in the review of the method, exposure limits and conclusions of the HHRA, but did not provide any direct opinions on the HHRA to this Panel.

The Panel accepts the method used for the HHRA and understands that hazard quotients (HQ) greater than one, but less than ten represent a potential low to moderate risk to human health with regard for the conservatism built into the assessment. The Panel finds that conservative assumptions were made in the assessment. The Panel understands the conclusions of the HHRA and that this methodology is commonly accepted. The Panel notes that there were numerous predicted exceedances of the HQ greater than one in acute and chronic cases and there were also predicted ILCRs over 1 × 10^{-5}. When an HQ value of one is met or exceeded, the Panel agrees that it is important for the Applicant to conduct a critical assessment of that exceedance and to also look at the consequence of that exceedance. The Panel is of the view that exceedances should not be dismissed just because the assumptions used in the HHRA were conservative.

The Panel is concerned with Hammerstone's conclusion that there may be future regional health effects from the activity in the region and as with air quality effects, it is understood that the Project has a limited contribution; however, the Panel is of the opinion that Hammerstone has a responsibility to contribute to regional solutions to human health issues. As a condition of approval, the Panel requires the Applicant to participate actively in regional solutions to human health issues, including any future human health exposure studies.

3.3: Noise

3.3.1: Views of the Applicant

The Applicant conducted a Noise Impact Assessment (NIA), to establish and assess operational noise impacts that would be attributable to its Project. Hammerstone submitted that in conducting its noise assessment and monitoring it was guided by Noise Control Directive 99-8 of the Energy Resources Conservation Board (ERCB), as it stated that Alberta Environment (AENV) does not have noise regulations specifically applicable to its proposed facility. Construction noise was not assessed by Hammerstone as it assumed that the noise produced during construction of the Project would be lower than the noise produced during operation.

The Applicant submitted that the major noise sources from the Project would include the limestone processing complex, primary crushers, conveyors, excavators, drills, dozers, backhoes and haul trucks. The predicted noise levels were based on the assumption that the facility would operate 24 hours a day, every day of the year. It also stated that noise generated during limestone quarrying and processing would be located on quarry benches or the quarry floor between 20 m and 40 m below grade.

Hammerstone predicted that there would be a night-time noise level exceedance at full commercial operation, over the permissible sound level (PSL) dictated by the ERCB directive, of 4 dBA at the Trapper's Cabin receptor location.

The Applicant conducted noise surveys to address the requirement within its NRCB Muskeg Valley Quarry (MVQ) approval in July and October 2006, May 2007, May and July 2008 and February 2010. Hammerstone observed a measured noise level night-time exceedance at the Trapper's Cabin in October 2006. Hammerstone reported in a 2007 summary document, that the noise generated at the Fort McKay Industrial Park was readily apparent and of a magnitude likely sufficient to contribute to the measured noise levels. It also indicated that the consistent noise levels observed at Site 1 across the two survey periods in 2006 suggested that the MVQ sources were not solely responsible for the measured increase in noise levels at the Trapper's cabin. However, in the October 2006 noise survey report, Hammerstone stated that the night-time noise levels should be considered non-representative due to bird noise in the dawn chorus which might have affected the data. During the May 2007 noise survey, the Applicant observed that the night-time noise levels met the

PSL, but the daytime noise levels were unrepresentative due to high winds. Subsequent noise monitoring was conducted at the new air quality monitoring location, which is located approximately 2 km to the south-southwest of the MVQ southern boundary, and the Applicant had not observed any further exceedances of the PSL at this location.

The Applicant committed to mitigating noise with the following measures which it believed should result in meeting permissible sound levels:

- use noise-attenuating jackets around stationary equipment;
- where and when possible, position equipment in sheltered locations;
- only blast during daytime hours;
- install noise abatement accessories on earth moving equipment where appropriate;
- put limestone processing equipment indoors;
- use conveyor systems with low noise output; and,
- enclose conveyors where appropriate.

Hammerstone also stated that because full commercial operation would not occur until 2020, it had sufficient time to reduce noise levels.

The Applicant committed to implementing an ambient noise monitoring program which would include, as a minimum, noise measurement over a 24 hour period at least once per year during operations.

3.3.2: Views of the Panel

The Panel notes that the ERCB Noise Control Directive 99-8 has been replaced by Directive 38 in February of 2007. The Panel does not expect that the Applicant would have revisited its noise predictions but notes that the new directive requires the addition of ambient noise levels in the modeling and the predicted levels for the Project would likely be higher if these ambient noise levels had been included. The Panel observes that there are predicted exceedances of the PSL at the Trapper's Cabin location.

The Panel acknowledges that there were conditions related to noise within the NRCB MVQ approval including adherence to the ERCB noise directive and the implementation of a routine noise monitoring program. The Panel further acknowledges the requirement of monitoring at the Trapper's Cabin. The Panel has reviewed all the noise surveys conducted for the MVQ that were submitted by the Applicant to the NRCB by the way of a May 2010 letter. The Panel observes that there was an exceedance found during one monitoring event of the night-time PSL at the Trapper's Cabin. The Panel further observes that after 2007, noise monitoring was not conducted at the Trapper's Cabin, but at the air quality monitoring location approximately 1.4 km to the south of the Trapper's Cabin, on the East side of the Muskeg River. The Panel notes that the ERCB noise directive is receptor based and specifies that dwellings within 1.5 km need to meet the calculated permissible sound level as dictated by the guide. The Panel notes that the Trapper's Cabin is less than 1.5 km from the quarry location.

The Panel finds that noise monitoring conducted at the new air quality monitoring location is not representative of the noise levels that could be expected at the Trapper's Cabin which has been identified as a dwelling for the purposes of the ERCB noise directive. The Panel also finds that there have been instances when the monitoring was not conducted in ideal conditions (for example during high winds, on snow covered ground) and therefore have limited representative noise level results. The Panel also notes that there are discrepancies in the October 2006 comments from Hammerstone as to why there was an exceedance observed for the night-time noise level. The Panel suggests that the contributions from other noise sources could have been isolated and removed from the data rather than discounting the whole of the night-time data. As a result, the Panel lacks confidence in the value of the noise monitoring results conducted to date by the Applicant, in determining the impact of noise on nearby residents.

The Panel continues to have concerns about noise arising from the Project due to the modeled and realized exceedances. In a 2008 agreement between Birch Mountain Resources Ltd. (now Hammerstone) and the Community of Fort McKay, the Panel observes that the community is concerned about the increase in background noise levels in the region. Therefore, as a condition of approval, Hammerstone Corporation shall, to the satisfaction of AENV:

- adopt and adhere to the requirements of the current ERCB noise directive;
- implement a variety of operational noise reduction measures such as mufflers, silencers and shielding, road maintenance, and traffic routing;
- implement a routine noise monitoring program through the life of the quarry and in cooperation with and input from local stakeholders and community residents; and,
- apply further mitigative measures, if exceedances of permissible sound levels are detected by the monitoring at the Trapper's Cabin or other representative location.

The above noted condition is based on the aforementioned condition in the MVQ approval. The Panel appreciates that there have been challenges in conducting noise monitoring at the exact location of the Trapper's Cabin and encourages discussions between the parties as this location is important for assessing noise impacts. However, if an agreement cannot be reached, the Panel suggests that there are more representative locations that could be used for assessing noise impacts on the community than the air quality monitoring station location.

The Panel is of the opinion that Hammerstone needs to be accountable to the local community and to other stakeholders with respect to the aforementioned condition. The Panel acknowledges that the NRCB does not have the jurisdiction to enforce its conditions; while Hammerstone and the NRCB look to the ERCB's noise directive as a definitive statement on the issue of industrial noise, the Hammerstone application is not a responsibility of the ERCB with respect to the noise issue. Should there be any complaints with respect to noise, the Panel recommends that they be addressed with Alberta Environment and the community.

3.4: Groundwater

3.4.1: Views of the Applicant

Hammerstone described the hydrogeology of the Project area at both a local and regional scale. The description included evaluations of hydrostratigraphy, the groundwater flow regime, groundwater quality, and changes to those factors resulting from the proposed quarrying and associated reclamation activities.

Hammerstone identified the key hydrogeological issues arising from the Project as:

- changes to groundwater flow in the vicinity of the Project
- potential impacts to surface water flows and wetland areas, and
- changes in quality of groundwater flowing through the Project area.

The local study area chosen by Hammerstone consists of the complete Hammerstone development area (including the Muskeg Valley Quarry) plus a 1 km buffer around the development area. Hammerstone said this includes the area in which groundwater might be directly affected by quarry activities.

Hammerstone chose the Muskeg River watershed for the regional study area in which indirect effects arising from the Project might occur. Hammerstone showed that the watershed includes the Muskeg Mountain Upland to the east, which constitutes a regional area of groundwater recharge for post-Cretaceous and Upper Devonian geologic units in, and east of, the Project area. The watershed extends to about 80 km east, northeast and southwest of the Project area and the western boundary was taken as the Athabasca River.

Hammerstone relied on a review of existing government reports and publications for its regional evaluation. For the local study it used information from private exploration programs in the area, from EIAs completed in the region, and from its own drilling, testing and field observation program. This included data from groundwater investigations conducted for the EIA of the Muskeg Valley Quarry.

Hammerstone presented site-specific hydrogeological information from exploratory programs it completed at the site. This included seventeen boreholes drilled within the Project area. Fourteen of these were completed as individual monitoring wells; multiple wells, containing one production well completed in Unit 2, were installed at five locations. In addition, Hammerstone used information from twelve boreholes at separate locations that were previously installed at the Muskeg Valley Quarry. Six of the latter boreholes were completed as monitoring wells. Hammerstone derived hydraulic properties of rock units from hydraulic tests (pumping and/or slug tests) it conducted at each of the five sites.

Hammerstone submitted results of groundwater chemical analyses of 18 water samples collected from monitoring wells within the development area. Water samples were taken largely from the more permeable Unit 2 limestone, but included six taken from wells completed in Units 1 and 3, below and above Unit 2, respectively. One sample was taken from undifferentiated Basal McMurray and Quaternary sediments in the now protected Quarry of the Ancestors.

Calculations of the amounts and rates of groundwater seepage into the proposed quarry pit constituted an important part of Hammerstone's groundwater assessment. Hammerstone presented estimated amounts of groundwater that would flow into the quarry at key stages of Project development and included the anticipated effect that construction of the proposed gypsum storage might have at the end of quarry life (in 2060). Hammerstone presented revised seepage calculations after it determined that less surface water than originally predicted would be available to fill the proposed quarry lake.

Hammerstone said it used Darcy's Law in its groundwater seepage calculations and included a number of significant assumptions in those calculations. It indicated that the assumptions included:

- a constant-head condition at a distance of 2 km from the quarry walls
- a constant hydraulic gradient of 0.01 to 0.03 toward the quarry during quarrying
- uniform aquifer parameters as determined by pumping and slug testing
- an absence of drainage from adjacent muskeg and saturated sands above bedrock because berms would surround the quarry, and
- hydraulic conductivity of proposed flue gas desulphurization (FGD) storage areas would be equivalent to liner material which was laboratory tested at 8.5×10^{-11} m/s.

Geological Setting

Hammerstone explained that the sedimentary rocks of the Project region consist of two sequences that are bounded by unconformities and become thinner to the east. The lower sequence consists of Paleozoic carbonate-evaporite rocks resting on the Precambrian surface and is unconformably overlain by a sequence of clastic rocks of Mesozoic age.

Hammerstone said that, in the Project area, the Paleozoic sequence is about 300 m thick and belongs to the Devonian Elk Point and Beaverhill Lake groups. The Mesozoic rocks consist of the Mannville Group, which contains the McMurray Formation, and ranges from 0 to 150 m in thickness.

Hammerstone explained that the rock units in the area are generally flat-lying with a gentle (<1°) dip to the west, but that there are structural disturbances resulting from basement faulting, salt dissolution, karst development, and erosion. It said that structural and erosional processes have exposed limestones of the Devonian Waterways formations near the lower reaches of the Muskeg River.

Hammerstone showed that at the scale of its regional study area, the bedrock geologic units consist of limestone and shale of the Devonian Waterways Formation at, and west of, the proposed Hammerstone Quarry. To the north, south and east of the quarry the geologic units consist of rocks comprising the Lower Cretaceous McMurray, Clearwater, and Grand Rapids formations progressing from west to east, respectively. Hammerstone indicated that, while the Waterways and McMurray formations are located in the lowest part of the Muskeg River basin, the Grand Rapids Formation dominates the uppermost elevated parts of the basin.

Hammerstone showed that the bedrock formations present beneath the local study area consist of Devonian limestone of the Moberly Member of the Waterways Formation in most areas of the western two-thirds of the Project area. It also showed that in the eastern third of the Project area the subcropping bedrock belongs to the McMurray Formation. Hammerstone indicated that it is the limestone within the Moberly Member that constitutes the source rock for its proposed quarry.

Hammerstone indicated that the Moberly Member is about 40 to 45 m thick in the local study area and is underlain by about 102 m of other members of the Waterways Formation, the Christina, Calumet and Firebag members. It said that the Christina Member consists mainly of calcareous shale. It also showed that in about the eastern one-third of the area the Moberly Member does not form the bedrock surface because it is overlain by sediments of the McMurray Formation. Hammerstone stated that the McMurray Formation consists of oil sand, shale and silicified sandstone and attains a thickness of about 30 m along the eastern Project boundary. Hammerstone informally divided the preserved part of the Moberly Member into four units, which it numbered from one to four, with Unit 4 being uppermost in the sequence. It presented a table which described the lithology and thickness of the four units (Table 4).

Table 4: Stratigraphic Column for the Moberly Member in the Hammerstone Project Area (Table 1.2, Environmental Impact Assessment, May 2006)

Unit	Lithology	Average Thickness
Unit 4	Massive limestone	0 to 6 m
Unit 3	Nodular limestone, interbedded limestone/calcareous shale, calcareous shale	20.5 m
Unit 2	Fossiliferous and nodular limestone	4.5 m
Unit 1	Nodular limestone, minor calcareous shale	13 m

Hammerstone said that the purest limestones are present in Units 2 and 4, but that because of local erosion, Unit 4 is not present everywhere in the Project area. It also indicated that Unit 2 is stained with bitumen in many places.

Hammerstone said the unconsolidated Quaternary sediments overlying bedrock in the local study area consist primarily of a thick layer of glaciofluvial sand and large boulders in the north and northeast part of the Project area. It further indicated that a probable eroded lateral moraine exists as a 13 m high ridge trending to the southwest along the northeast Project boundary and small isolated patches of glacial sand and boulders are present throughout the Project area.

Hammerstone explained that it found a number of features that it interpreted to be sediment-filled karst holes during opening of the Muskeg Valley Quarry. The features consisted of areas where Devonian sediments had been chemically eroded and the resulting voids in-filled with green-brown clay, oil sand and boulders. Hammerstone said it did not know the age of these features but they are likely to be in part Quaternary.

Hammerstone explained that karst features exposed by quarrying in the Muskeg Valley Quarry included subvertical paleokarst dissolution channels averaging 10 to 50 cm wide and filled with green clay and sand. It said the karst included small discontinuous normal faults with 50-250 cm offset subvertical zones of intense fracture development averaging 50 to 100 cm wide, and large cone shaped paleokarst holes, averaging 20 m wide and 10 to 20 m deep.

Hammerstone said the size and frequency of paleokarst features decreases downward. It said Unit 4 limestone is highly dissected and that the 10 to 20 cm wide dissolution channels are spaced roughly every 5 m in that unit. Hammerstone found a number of lateral lenses of green clay and bitumen-stained sand near the top of Unit 3 and some large paleokarst holes averaging 20 m wide and up to 20 m deep. It said that the large paleokarst holes terminate in Unit 3. Hammerstone indicated that Unit 2 is characterized by subvertical paleokarst dissolution channels filled with green clay and sand, averaging 10 to 30 cm wide, and spaced roughly every 10 m and that localized areas of more and less intense fracture development are also present. It said Unit 1 has not been exposed sufficiently in the pit to assess the fracturing and karsting.

Hammerstone emphasised that the karst features (channels, holes, and fractured zones) are not open voids, but rather, have been infilled with clay and minor amounts of oil sand. It said that a number of drill holes for piezometers and monitoring wells intersect and span intervals of extensive fracture and karst development, but still exhibit hydraulic conductivity in the order of 10^{-8} m/s. Hammerstone said it tested the permeability of unfractured rock from Unit 3 and measured values in the range of 5×10^{-11} m/s. It said that this strongly indicates that the karst features and fractures contribute the majority of the permeability observed in the Project area limestone, and that the permeability values it used in determining groundwater flow and seepage rates appropriately account for karst features and fractures in those determinations.

Groundwater Flow

Hammerstone indicated that at the regional scale of the Muskeg River basin, the groundwater flow is dominated by a strong regional downward gradient beneath the Muskeg Mountain Upland, 30 km to the east of the Project. It said groundwater moves westerly to northwesterly from the Muskeg Mountain Upland toward the Athabasca River.

Hammerstone stated that published information indicates that the main aquifers in the region consist of the Basal Aquifer of the McMurray Formation and some Quaternary deposits. It said that hydraulic conductivity of Upper Devonian formations is low, ranging from 1×10^{-7} to 1×10^{-11} m/s, with a median value of 3×10^{-9} m/s. Hammerstone said exceptions to the low permeability of Devonian units occur where they are modified by fractures and karst features. It expected conductivities of the McMurray Formation to be higher, and range between 1×10^{-5} and 3.2×10^{-8} m/s.

Hammerstone said that hydraulic conductivities derived from its hydraulic testing of the Moberly units are also generally low and consistent with regional published values. However, it stated that it found that the Moberly Unit 2 is generally more permeable and forms an aquifer in much of the southern part of the Project area.

Hammerstone said that groundwater flow in the local study area is mainly westward and is demonstrated by flow within Unit 2. It expected that lateral recharge to the Moberly units is mainly from the east, from the adjacent Basal Aquifer of the McMurray Formation and from surficial sand and gravel deposits.

Hammerstone indicated that the hydraulic gradient within Unit 2 is about 0.005, but that not enough data were available to demonstrate the direction and magnitude of the vertical gradient within the Moberly units. It expected the lateral and vertical groundwater flow velocities in Units 1 and 3 to be very slow and on the order of 1 cm per year or less. In contrast, Hammerstone expected flow within Unit 2 in the southern part of the local study area to be as high at 10 to 100 m per year.

Hammerstone said a comparison of hydraulic heads within Unit 2 with elevations along the Muskeg River indicates potential recharge to the river from Unit 2 along the southern half of the quarry, but that gradients are neutral or only slightly upward along the northern half. Hammerstone stressed, however, that Unit 2 is not directly connected to the river because Unit 3 and 4 are exposed along the river and recharge through Unit 3 is expected to be very low.

Hammerstone responded to an SIR (SIR 222(a), December 2007) about the small 5-m vertical separation that is shown in Fig. 1.8 of the EIA between the permeable Unit 2 and the Muskeg River near the southwest boundary of the quarry, and whether this condition could result in high rates of water inflow from the river to the quarry through Unit 2 in that area. Hammerstone said the available data about monitored hydraulic heads in that area do not support that notion because the heads in Unit 2 are much higher than the Muskeg River elevation. It said the maintenance of the high heads means that Unit 2 is confined in that area and there is not a strong hydraulic connection between Unit 2 and the river.

Hammerstone said its calculated rates of groundwater inflow to the quarry (Table 5) are expected to be overestimated because it used conservative assumptions. However, Hammerstone indicated that calculated rates do not account for possible flows if high-yielding karst solution channels are encountered during quarrying.

Table 5: Groundwater Inflow During Quarrying (Table 7.4, Environmental Impact Assessment, May 2006)

Year	Quarry Groundwater Inflow (m3/day)
2009	5
2011	7
2015	10
2040	186
2060	393
2060*	204

* Including backfilled FGD solids and fill material.

Hammerstone calculated that rates of groundwater inflow would range from an initial 5 m^3/day to as much as 393 m^3/day at the end of quarrying. It estimated that about 85 percent of the groundwater inflow would drain from the more permeable parts of Unit 2 in the southern half of the Quarry and that inflows would be negligible (10 m^3/day or less) before the southern part of the quarry would be opened.

Hammerstone said it monitored groundwater inflow to the Muskeg Valley Quarry during operations and found only minimal seepage of water into the quarry. It reported that water inflow is localized in Units 3 and 2 along outer pit walls adjacent to wetlands, suggesting inflow of surface muskeg water through fractures. Hammerstone said there has been very little or minor seepage observed from large paleokarst holes in Unit 3 or from fractures in the pit away from the walls. It stated that groundwater seepage into the quarry has been so small that no accumulations or flow measurements have been possible.

Hammerstone indicated that the FGD solids storage area, if constructed, would be encapsulated in a low conductivity liner and would reduce the amount of groundwater inflow substantially. It indicated that under those conditions the maximum groundwater inflow would be reduced to about 204 m^3/day.

Hammerstone also speculated that the lined FGD storage could block groundwater inflow from the east and result in groundwater mounding on the east side of the quarry. It said the mounding could be mitigated with drainage features that would direct groundwater around the storage area and that this would be evaluated as the storage area design progressed.

Hammerstone anticipated that there would be a net decrease of natural groundwater discharge to both the Muskeg and Athabasca rivers due to development of the quarry. It calculated the decrease to be about 16 and 211 m^3/day for the two rivers at peak development, respectively. For comparison, Hammerstone said that other existing and approved projects presented for the Muskeg River Mine Extension by Shell (2005) indicate a decrease in groundwater discharge of 1,450 m^3/day to the Muskeg River and 15,360 m^3/day to the Athabasca River due to required aquifer dewatering by 2020. Hammerstone said that these other dewatering programs could, however, be concluded by the time the Hammerstone Project would reach its maximum extent.

Groundwater Quality
Hammerstone said it reviewed results from over 100 chemical analyses of groundwater reported in the Alberta Environment groundwater database and within the boundaries of the Muskeg River drainage basin for the years between 1975 and 1982. It said the analyses provided information about groundwater chemical quality within surficial deposits, the McMurray Formation, and the Beaverhill Lake Group.

Hammerstone said that groundwater within Quaternary sediments is generally of the sodium magnesium-calcium bicarbonate type, whereas the McMurray Formation contains groundwater characterized by two compositional types: a sodium magnesium-bicarbonate type, and a sodium bicarbonate-chloride type. Hammerstone said the latter compositional type of McMurray groundwater is more widespread than the former. Hammerstone reported that the main dissolved ions in groundwater in the Beaverhill Lake Group are sodium and chloride and that total dissolved solids concentrations may range between 5,000 and 10,000 mg/L.

Hammerstone reported that chemical analyses of groundwater from within the Project area showed that the local major-ion chemical quality is similar to that found on the more regional scale. It said that groundwater from the Moberly Member (mainly Unit 2) shows a mixing trend between sodium bicarbonate and sodium-chloride composition and that this supports its view that Moberly groundwater is recharged from the adjacent McMurray Formation to the east. Hammerstone reported that Moberly groundwater is naturally elevated in salinity with chloride and TDS concentrations ranging as high as 5,220 and 11,700 mg/L, respectively.

Hammerstone also presented a suite of metals analyses for groundwater within the Project area. It noted that concentrations of some metals, including aluminum, antimony, arsenic, cadmium, chromium, iron, manganese and selenium were naturally elevated. Hammerstone referred to the metals analyses to be for dissolved metals in the text of the EIA, as metals in its Table 7.6, and as total metals in laboratory reports it presented in Appendix F3 of Volume 2 of the EIA. It also reported that turbidity of groundwater samples was generally high and ranged from 3 to 5,700 NTU.

Hammerstone also reported that its analyses showed low levels of hydrocarbons were detected in most groundwater samples. It stated that naturally occurring hydrocarbons in the local groundwater were not unexpected, in view of bitumen occurrences that were noted in drill and core samples collected in the Project area during the early explorations phase.

Hammerstone concluded that the operations of quarrying would not result in a significant impact on local groundwater quality. It said that local groundwater flow would be toward the quarry and that it would be unlikely that any surface and groundwater that would accumulate in the quarry would be able to flow out of the pit if it were stored in areas where the low permeability Units 1 and 3 were exposed.

Hammerstone stated that a new equilibrium between groundwater inflow and outflow would be established during the time of filling of the lake. It said there could be only a small amount of exchange through Units 1 and 3 because of their low permeability, but it would expect a greater level of exchange to occur between the lake and Unit 2. Hammerstone expected the lake water to consist primarily of surface water (99 percent) and that the resulting water quality would be good. It expected that any lake water that would infiltrate to the groundwater system would result in a dilution of baseline groundwater quality.

Cumulative Effects

Hammerstone considered cumulative effects on groundwater quantity of the Project, the adjacent Shell Lease 90 operations and those of all other current and proposed oil sands mines in the Muskeg River watershed area. It said that the proposed Shell Muskeg River Mine Expansion on Lease 90, in particular, has the potential to interact cumulatively with the Hammerstone Project. Hammerstone reasoned that the interaction arose from the overlap and close proximity of the Project and Lease 90, and because of the probable hydraulic connection between Hammerstone's Unit 2 and the Basal McMurray Aquifer located beneath Lease 90. Hammerstone said that information from Shell's EIA for the Muskeg River Mine Expansion (Shell, 2005) indicated Shell's required dewatering of the Basal McMurray Aquifer and Lease 90 would exceed 20 m by 2020 before closure and cessation of dewatering would occur.

Hammerstone summarized the expected cumulative effect of its own impacts, those of aquifer dewatering by the proposed Muskeg River Mine Expansion, and effects of all other current and proposed mines (Base Case) in the Muskeg River watershed (Table 6).

Table 6: Summary of Decrease in Groundwater Discharge (m^3/d) (Table 7.7, Environmental Impact Assessment, May 2006)

	Base Case	Muskeg River Mine Expansion	Hammerstone	Total
Muskeg River				
2007	1,000	0	2	1,002
2012	1,370	20	3	1,393
2020	1,450	10	4	1,464
Athabasca River				
2007	6,800	190	3	6,993
2012	15,620	40	4	15,664
2020	15,360	190	6	15,556
Note: Modified from Shell (2005).				

Hammerstone estimated that the cumulative amounts of groundwater diversions from the Muskeg and Athabasca rivers by the Hammerstone and Shell Muskeg River Mine represent less than two percent of the total reduction in groundwater discharge to the two rivers that is anticipated for all other projects in the Muskeg River watershed.

Hammerstone stated that because there would be no degradation in groundwater quality by the Project, no cumulative effects on groundwater quality are anticipated.

3.4.2: Views of the Panel

The Panel finds Hammerstone's evaluation of the geological and hydrogeological conditions related to the Project to be of high professional standards and of sufficient detail to allow the Panel to make informed decisions about potential hydrogeological impacts of the Project, and to formulate mitigative measures with confidence. The Panel considers several issues to be of high importance with regard to potential groundwater impacts related to the Project.

The Panel has considered the issue of enhanced secondary permeability induced by karst processes, which are expressed by solution channels and extensive areas of intense fracture development within the present Muskeg Valley Quarry, and by extension, in the proposed Hammerstone Quarry. The Panel is satisfied with Hammerstone's evidence, based on observation in the existing Muskeg Valley Quarry, that large karst solution channels have not been found in rock units below the uppermost Unit 4 limestone. Similarly, the Panel accepts Hammerstone's evidence that even where zones of intense fracture development do exist in the lower Units 2 and 3, those fractures are for the most part filled with clay, sand and bitumen.

The Panel agrees that, while the infilled fractures do significantly increase the bulk, or overall permeability of rock units in the Project area, the resulting bulk permeability of about 1 x 10^{-8} m/s is not great enough to cause catastrophic influxes of water in areas where the Quarry will be close to the Muskeg River.

The Panel is also satisfied with Hammerstone's explanation that field hydraulic conductivity tests on monitoring wells that penetrate and span zones of intensive fracture development adequately represent the bulk hydraulic properties of those zones. The Panel also accepts Hammerstone's argument that the significantly higher elevations of hydraulic head in Unit 2, compared with the elevation of the Muskeg River in the southwest part of the quarry, indicate that a strong hydraulic connection between Unit 2 limestone and the river does not exist in that area.

The Panel does note Hammerstone's evidence, however, that fractured zones do extend vertically through Units 3 and 2 at the existing Muskeg Valley Quarry and that numerous large solution holes (dolines), averaging 20 m wide and up to 20 m deep, have been observed. The Panel also notes that Hammerstone's calculations and predictions indicate that groundwater flow rates in Unit 2 in the southern half of the Project may be as high as 10 to 100 m/yr. The Panel, therefore, is not completely convinced that all of the fractured zones are clay filled, and that hydraulic continuity is absent everywhere between Unit 2 and the Muskeg River in the south part of the proposed quarry.

The Panel recommends, therefore, that Hammerstone rigorously evaluate the occurrence of karst features in, and adjacent to the quarry, including fractured areas exposed during stripping of overburden as the 200 m buffer area between the Muskeg River and the quarry is approached in the southern half of the quarry. The Panel further recommends that Hammerstone adjusts and widens the 200 m buffer strip if it finds that the abundance of fractures and solution holes (dolines) increases to the point where strong hydraulic connections between the quarry and the river is suspected or possible.

While the Panel is concerned about the potential for karst related incursions from the Muskeg River in the southwest part of the Project area, it accepts Hammerstone's position that, in general, the rates of groundwater inflow to the quarry will be minimal and manageable. The Panel is particularly encouraged in this regard by Hammerstone's observations about the extremely low actual groundwater seepage that has occurred during operation of the Muskeg Valley Quarry to date.

The Panel notes Hammerstone's observation that groundwater flowing from the Basal McMurray Aquifer beneath Shell Lease 90 in the eastern part of the Project may impinge on the proposed liner-encapsulated FGD and spent lime storage areas and result in groundwater mounding east of the storage areas. The Panel agrees with Hammerstone's proposed mitigation measures to construct drainage features to direct groundwater around the storage areas. As a condition of approval, the Panel directs Hammerstone to work with Alberta Environment to ensure the groundwater drainage features are designed and constructed to Alberta Environment's satisfaction.

The Panel agrees with Hammerstone's position that the quarry will not result in a significant impact on groundwater quality because local groundwater flow will be directed toward and into the quarry, not away from the quarry. However, the Panel finds that there may be impacts local to the quarry and the proposed quarry lake that could result from seepage from the proposed FGD and spent lime storage areas. Such seepage could have adverse impacts to the quarry lake and ultimately the Muskeg River. The Panel is particularly concerned about the potential liberation of metals from the storage areas and their impact on the aquatic environment of the quarry lake and the Muskeg River.

The Panel notes that Hammerstone did not describe the field protocols and procedures it followed for sampling of groundwater from monitoring wells within the Project area. In particular, the Panel notes that Hammerstone did not report if water samples were filtered before acidifying and stabilization in the field, prior to submission to the laboratory for analysis of dissolved metals.

The Panel also notes that there appears to be confusion about the specific analyses performed to determine metals concentration in groundwater samples, as the metals analyses completed were variously reported as dissolved metals, metals, and total metals in different parts of the EIA. It further notes that most groundwater samples exhibited high to very high degrees of turbidity and high metals concentrations above established guidelines. Also, for these groundwater samples, laboratory analyses in Appendix F3 of the EIA were reported to be for total metals and were performed on samples as received by the laboratory, presumably without being filtered.

In view of these findings, the Panel concludes that there is a high probability that the metals concentrations reported in the EIA do not represent concentrations of dissolved metals occurring in Project area groundwater, but rather, of metals dissolved in the groundwater plus metals derived from clay and other minerals present in unfiltered and highly turbid water samples as a result of solubilization through strong acid digestion. The Panel finds, therefore, that the reported concentrations of metals are likely to be significant overestimates and do not represent natural background conditions for Project area groundwater.

The Panel is of the view that the establishment of baseline groundwater quality is important to enable the determination of any potential impacts that future activities such as quarrying, processing, and disposal of FGD solids and spent lime in the proposed landform may have on local groundwater and water in the proposed quarry lake. If a proper and true baseline is not clearly established, the Panel observes it will also not be possible to determine if deviation from baseline values and water quality exceedances are caused by the Project, should such exceedances occur.

Therefore, as a condition of approval, the Panel directs the Applicant to resample and analyze groundwater from all monitoring wells that have not been removed by quarrying to date. The Applicant must follow established protocols and procedures for sampling, handling, and analysis of the water samples for dissolved metals concentrations. As a condition of approval, the Panel also directs that analytical results and a description of protocols used to obtain those results must be submitted to Alberta Environment before issuance of the EPEA approval.

3.5: Surface Water

3.5.1: Hydrology

3.5.1.1: Views of the Applicant

Hammerstone Corporation (Hammerstone) defined hydrology as the study of surface water system flow dynamics and the relationships among precipitation, surface water storage, evapotranspiration, infiltration, surface runoff, and groundwater. Hydrology is intricately linked with other aquatic resources such as fisheries, water quality, and groundwater. Hammerstone stated that baseline studies and effects assessments were conducted for the local and regional surface water hydrology for the proposed Hammerstone Quarry Project (the Project). Hammerstone stated that construction and operation of the Project would affect hydrology within and outside of the Project area. The effects assessment was conducted using the boundaries of the Project, the Muskeg Valley Quarry (MVQ), the Aquatic Local Study Area (ALSA), and the Aquatic Regional Study Area (ARSA).

Hammerstone outlined that at the commencement of Project construction, muskeg areas within the boundaries of the Project area would be dewatered. Drained water would be collected and stored within the quarry water management system, consisting of an in-quarry water storage pond to capture and store all direct or diverted surface water coming in contact with the quarry, soil and other material stockpiles, and rock processing areas. Hammerstone explained that all groundwater seepage flows in the quarry would be diverted to the quarry water storage pond and that groundwater seepage into the quarry would not be expected to affect surface water discharge. To prevent off-site water from entering the quarry and quarry water management system, exclusion berms and interceptor ditches would be constructed along the perimeter of the quarry. Hammerstone highlighted that all required water for Project operation processes are proposed to be supplied from the quarry water management system. No external water is expected to be required, except for potable water that would be trucked to the site.

Hammerstone identified three drainage basins within the Project boundary: a northeast unnamed basin, a south-central unnamed basin, and an area draining, overland, directly into the Muskeg River. Several unnamed surface wetlands were located in the northern portion of the ALSA. Hammerstone outlined that the Project footprint would lay entirely within the Muskeg River direct drainage basin and the south-central unnamed basin, with approximately 70 percent located within the Muskeg River direct drainage basin.

Hammerstone proposed to construct a diversion channel to direct water drainage from the south-central unnamed basin north to a wetland at the mouth of the northeast unnamed basin. The diversion channel would then be extended northwest around the north end of the MVQ and drain into the Muskeg River. The diversion channel would be constructed prior to clearing, stripping, or quarrying operations activities that would affect the existing channel connecting the wetland to the Muskeg River and would remain in place until the Project is complete. Hammerstone stated that upon closure of the Project the diversion channel would be redirected, supplying surface water to the proposed quarry lake, which would subsequently have a constructed outlet channel to the Muskeg River. This would result in water from the northeast and south-central drainage basins draining through the lake to the Muskeg River, entering the river channel approximately 5 km downstream of the pre-disturbance confluence.

Hammerstone cited information for a number of flow-related parameters collected during baseline assessment investigations, including annual total flows, peak flows, and drought flows, as well as qualitative information on drainage patterns, to assess potential effects of the Project on hydrology. This information included various available historical and current local and regional data sources, specifically data collected by Hammerstone, the Water Survey of Canada, the Regional Aquatics Monitoring Program, the Meteorological Service of Canada, National Topographic System maps, and information from other industrial programs and reports.

Hammerstone stated that baseline conditions for mean annual total discharge and runoff were characterized by historical recorded streamflow data. Data from available monitoring stations were limited by the period of record and seasonal operation of stations. Hammerstone presented estimated annual total discharges and runoff at select locations within the ALSA. Hammerstone stated that, generally, annual flows increase and peak in the spring due to snow melt, are low during the summer with rainfall maintaining or slightly increasing flow in the fall, and decrease to annual low flows in the winter. Clearing of vegetation and quarrying activities were predicted to affect surface water runoff and infiltration rates, resulting in changes to total runoff to and discharges in streams. Hammerstone proposed to trap and collect runoff generated within the Project area within the quarry water management system, with this water being removed from the local and regional hydrological cycles. Hammerstone predicted that the impacts of the Project on mean annual discharge in the existing south-central and northeast basin channels are high, continuous, and long-term. In the Muskeg River, impacts were expected to be moderate near the upstream boundary of the Project and low downstream of the Project.

Hammerstone noted that peak flow (or flood frequency) analyses were conducted based on recorded maximum daily snowmelt and rainfall and that the results were correlated on the basis of drainage area. Peak (flood) flows were proposed to be potentially affected by the clearing of vegetation and infrastructure construction, as the proportion of runoff is typically higher from disturbed or developed areas than from natural areas. Hammerstone stated that annual peak discharges typically occur in the spring due to snowmelt and are sustained through early summer due to basin storage and rainfall. Peak flows also have the potential to occur during the summer and fall due to rainfall events. Hammerstone expected impacts of the Project on peak flows to be high, continuous, and long-term in the existing channels draining the south-central and northeast basin, primarily due to the operational and closure scenarios involving channel diversions. Impacts due to the Project to peak discharges in the Muskeg River were predicted to be moderate near the upstream end of the Project and low downstream of the Project. Hammerstone concluded that following reclamation there would be no measureable impact to peak discharges in the Muskeg River as a result of the Project.

Hammerstone estimated baseline low flow conditions and evaluated baseline and Project-impacted low flow conditions qualitatively due to the seasonal operation of monitoring stations and limited available data. Zero flows were recorded and observed during available seasonal periods of record at a number of monitoring stations. Hammerstone expected that, based on regional zero flows, zero flows could occur in all of the small channels draining the Project area during the open water season and that flows in relatively small catchments within the ALSA would frequently be zero in the winter. Hammerstone concluded that low flows within the ALSA would not be affected by the Project.

Hammerstone stated that baseline and Project-affected drainage patterns were qualitatively assessed, using available map and air-photo information. Drainage patterns in the ALSA would be permanently altered by the Project as a result of construction of the diversion channel and the quarry water management system. Hammerstone outlined that during operations, surface channels draining the south-central and northeast drainage basins would drain to a main diversion channel that would be diverted north around the MVQ and join the Muskeg River approximately 4 km upstream of the existing confluence. Following quarry activities, the diversion channel would be redirected south through the quarry lake, which once full, would drain to the Muskeg River through the lake outlet, approximately 5 km downstream of the existing confluence.

Hammerstone stated that process water would be supplied by runoff trapped and collected from the quarry in the quarry water storage pond during operations. Process water requirements were projected to increase from 255,000 m^3/yr at start-up to 718,000 m^3/yr approximately 30 years later to quarry closure. Hammerstone summarized that under normal precipitation conditions the water balance indicated that there would be sufficient runoff generated within the quarry and captured by the quarry water management system to satisfy process water requirements, though a shortfall might be experienced approximately 5 to 10 years into the Project should a prolonged low precipitation period also occur during this period. The risk of a water shortfall would decrease as additional quarry areas open up.

Hammerstone proposed to construct a quarry lake following Project closure. The proposed quarry lake would be filled by direct runoff from within the quarry footprint and surface runoff provided by the diversion channel draining the south-central and northeast drainage basins. Hammerstone provided an estimated water balance for the quarry lake, summarizing that inflows would include runoff from the northeast and south-central unnamed basins, direct precipitation, local runoff, and relatively minor amounts of groundwater. Water losses from quarry lake would include evaporation during lake filling, and evaporation and lake outflows when the lake is filled. Hammerstone estimated that approximately 73 percent of the total annual precipitation would occur as rain and 27 percent as snow, and that groundwater inflows would vary from approximately 5 m^3/day to 204 m^3/day. Lake evaporation was also estimated.

Hammerstone stated that under assumed Project reclamation conditions, it would take approximately 75 years for quarry lake to fill. Hammerstone stated that this had changed from the initial estimate as a result of surface water drainage changes associated with the Shell Muskeg River Mine Expansion Project that would reduce the available water for the quarry lake. As a result of the changes, Hammerstone indicated that the initial estimate of 54 years to fill the quarry lake would increase to 162 years. Hammerstone did not view this as being acceptable and subsequently made changes to the conceptual design of the quarry lake (see Section 4), reducing the volume of water required to fill the lake, which resulted in an estimated lake-filling period of 75 years.

Hammerstone stated that cumulative effects were assessed by superimposing the results of the Project impact assessment on the cumulative effects assessment prepared by Albian Sands Energy Inc. (2005) for the Muskeg River Mine Expansion Project. Hammerstone predicted that the Project would have a relatively small incremental impact on annual total discharges in the Muskeg River basin and would have no impact on annual total discharges in the Muskeg River basin after reclamation. Hammerstone rated the contribution of the Project to changes in peak flow discharge at the mouth of the Muskeg River as small and the impacts of the Project on peak flows as negligible during operations and after reclamation. Hammerstone expected the impacts of the Project to low flows to be low and might slightly counteract the effects of other projects in the ARSA. The impacts of the Project on low flows in the Muskeg River would also be expected to be negligible during operations and after reclamation.

Hammerstone stated that Project effects on hydrology would primarily be the result of clearing, ground disturbance, flow diversion, and water consumption/withdrawals. Hammerstone concluded that many of these effects could be managed by applying mitigation methods during design, construction, and operations. Hammerstone committed to complying with applicable provincial and federal policies for the protection of water resources and that appropriate mitigation techniques would be employed during construction and operation of the Project.

3.5.1.2: Views of the Panel

The Panel finds that Hammerstone conducted reasonable baseline studies and effects assessments for the local and regional surface water hydrology for the proposed Project. The Panel understands that hydrology was referred to as the dynamics of flows in surface water systems and its linkages with other aquatic resources. The Panel appreciates that surface disturbances can have a definite and significant effect on surface water flows and is considered an important impact from projects such as the one proposed by Hammerstone.

The Panel acknowledges that the construction and operation of the Project will have a direct and significant impact on hydrology within the ALSA and that hydrologic characteristics will play a significant role in the overall reclamation plan and goal of a lake and functioning ecological system.

The Panel accepts that the methods used and information collected for the baseline and effects assessments were reasonable and demonstrate a relatively good understanding of the hydrology, including characteristics of mean annual total discharge, runoff, peak discharges, low flows, drainage patterns, and water balances, within the ALSA and ARSA. The Panel also appreciates difficulties, variability, and uncertainties associated with continuous annual stream gauging and hydrologic assessments.

The Panel notes that muskeg dewatering will occur prior to Project construction and that a key part of the water management system is the creation of a surface water diversion channel. The Panel finds that the intention to create a closed circuit area for the Project, which will capture all water coming into contact with the quarry, soil, and rock processing areas, and prevent run-on and runoff to and from the Project, including the use of interceptor ditches and exclusion berms, is appropriate. The Panel understands that additional berms may be considered along the proposed buffer zone adjacent to the Muskeg River. This is particularly pertinent where the quarry footprint nears the floodplain, as there is potential for water flow in these areas during high discharge events in the Muskeg River when water may not be limited to the current main channel. Though these systems will alter the local hydrology, including altering the current drainage basins and relocating the drainage discharge from the ALSA into the Muskeg River, the resulting impacts are considered by the Panel to be relatively minor and are not anticipated to result in significant changes to hydrologic conditions within the Muskeg River or outside the ALSA. The Panel notes that the cumulative effects on hydrology as a result of the Project in the ARSA are also predicted to be limited.

The Panel recognizes that water collected within the quarry water management system and quarry water storage pond will be used to meet water requirements for Project operations (i.e., limestone processing). No external water is expected to be required, except for potable water which will be trucked into the site. The Panel is aware that water balance estimates predicted that the quarry water management system will meet the water requirements as stipulated by Hammerstone, but that a potential water shortage may exist when water requirements increase by approximately 255,000 m^3/year at a time approximately 5 to 10 years into the life of the Project should a simultaneous prolonged low precipitation period occur. Although this issue was identified by Hammerstone, the Panel did not find that a potential solution to this problem was proposed. The Panel encourages Hammerstone to identify potential mitigation options in advance with the appropriate regulator(s) and/or authorities should a water supply shortfall occur. The Panel recommends that Alberta Environment require Hammerstone to prepare a contingency plan prior to operations to address a potential water shortfall.

The Panel notes that should the volume of collected water exceed operational requirements of the Project, occasional discharges of collected water from the quarry water storage pond may be required. Though this is not expected to have a significant impact on the hydrology at the site, potential water quality issues may arise and are considered by the Panel elsewhere (Section 3.5.2).

The Panel understands that the filling of the quarry lake will be dependent primarily on surface water inputs and will include an outlet to the Muskeg River once full. The Panel considers the water balance approach, and presentation of it, to characterize the filling of the quarry lake as reasonable and notes that the updated estimates predict a lake-filling period of 75 years. The Panel understands that wetlands and ecosystem functions will start developing before the estimated final filling time. The Panel is cognizant of the effect that any changes to the overall reclamation plan and conceptual design of the proposed lake, landform, and drainage patterns will have on these estimates. The Panel concludes that the filling period and volume of water required for the reclamation objective needs to be updated in accordance with the scheduled review and updates of the reclamation plan (i.e., every 5 years). Any perceived issues with the hydrologic regime should be dealt with on a continuous basis and assist in guiding any adaptations of the reclamation plan throughout the life of the Project.

The Panel accepts that by employing proper mitigation measures during the design, construction, and operation of the Project, Hammerstone should be able to limit potential impacts to the local and regional hydrology. Following reclamation, relatively negligible effects on the local and regional hydrology as result of the Project are expected. The Panel expects Hammerstone to comply with all applicable provincial and federal policies for the protection of water resources and that appropriate mitigation techniques are employed during construction, operation, and reclamation of the Project. As a condition of approval, the Panel also requires Hammerstone to actively participate in regional collaborations and associations linked with surface water issues and hydrology related initiatives.

3.5.2: Surface Water Quality

3.5.2.1: Views of the Applicant

Hammerstone Corporation (Hammerstone) stated that surface water quality might be affected by the Hammerstone Quarry Project (the Project). In addition to surface water quality effects commonly associated with surface disturbances (e.g., sediment loading), the Project might contribute to surface water quality changes beyond the boundaries of the Project area. Hammerstone identified that potential changes in surface water quality could occur directly, through the introduction of substances into waterbodies from Project development and operations, or indirectly, through changes in hydrologic regimes and natural water inputs and/or flows.

Hammerstone outlined that the Aquatic Local Study Area (ALSA), based on watershed principles, was used for the surface water quality assessment.

The ALSA included a west drainage, draining directly through non-channelized flow to the Muskeg River, an unnamed creek, which is a tributary to the Muskeg River, with both north and south tributaries, the Muskeg River bordering the Project site, and the Muskeg Valley Quarry drainage, that intercepts flows from the northeast and south-central drainages. Hammerstone stated that the Aquatic Regional Study Area (ARSA) included the Muskeg River watershed, and a portion of the Athabasca River from 5 km upstream of the confluence with the Muskeg River to upstream of the mouth of the Firebag River. Lakes included for acid deposition assessment were based on the Air Quality Regional Study Area (AQRSA)

Hammerstone assessed surface water quality baseline conditions based on available historical data and data acquired during field surveys. Potential surface water quality effects associated with Project impacts were assessed for the full Project development scenario, as were potential regional cumulative effects. Hammerstone reviewed existing surface water quality information from sampling programs in the vicinity of the ALSA, ARSA, and AQRSA conducted by governmental sources (federal and provincial), the Regional Aquatic Monitoring Program (RAMP), and by industry.

Hammerstone conducted baseline surface water and sediment quality sampling for waterbodies within the ALSA to identify spatial and temporal variations in water quality and to supplement historical datasets. Water quality data were compared to Alberta and Canada surface water quality guidelines.

Hammerstone stated that the ALSA was predominantly characterized as lowland, with greater than 70 percent of runoff generally occurring as interflow through peat layers. Hammerstone summarized that the three drainages, the northeast, south-central, and west (draining directly to the Muskeg River and containing one defined waterbody, a small lake in the northern portion of the ALSA), within the ALSA were typical of small tributaries in the Muskeg River watershed. Specific conductivity of the surface water was generally low due to a lack of groundwater baseflow contributions, with the exception of the western portion of a wetland within the northeast drainage. Hammerstone maintained that generally, nutrient, organic, and metal concentrations were relatively low in surface water in the drainages within the ALSA. Iron concentrations were commonly elevated in most sample locations, generally exceeding the guideline level, which was attributed to large areas of bogs or marshes within the ALSA. Hammerstone observed that total Kjeldhal nitrogen concentrations also commonly exceeded guideline levels, particularly in the small waterbody within the Muskeg River drainage, which was generally well oxygenated. Other occasional exceedances of surface water quality guidelines were identified; however no other consistent exceedances were recorded across the drainages.

Hammerstone summarized that limited spatial and temporal variations were observed for any physical or chemical water quality parameters. A spatial pattern of increasing parameter concentration was identified in the south-central drainage receiving water from the northeast drainage and that some seasonal variations were evident for dissolved oxygen and specific conductance within the south-central drainage.

Hammerstone stated that observed sediment texture varied slightly among sites sampled within the ALSA, with no spatial differences among drainage areas. Many metal concentrations were at low or non-detectable levels. Relatively high organic carbon concentrations were associated with high silt content. Hammerstone determined that no exceedances of the Interim Sediment Quality Guidelines were observed.

Hammerstone reported that water released from the Muskeg Valley Quarry interim settling system is monitored before and during releases and that water discharged into the unnamed tributary is tested at the pond outlet and near the mouth of the unnamed creek. Hammerstone noted that no exceedances of the release limits for total suspended solids (50 mg/L) or pH (6.5 to 9.5) had been observed.

Hammerstone explained that water quality sampling has been conducted in the Muskeg River upstream and downstream of the ALSA as a condition of approval for the Muskeg Valley Quarry and has been combined with data from other monitoring activities within the Muskeg River. Historical sampling programs have identified guideline exceedances for one or more parameters. Hammerstone stated that metal concentrations have been observed to continually be generally elevated in the Muskeg River, with natural concentrations often exceeding guideline levels. Concentrations of dissolved oxygen have been recorded to fall below the guideline range (an exceedance) during low flow winter conditions, occasionally reaching anoxic conditions, and organic constituents and nutrients have also occasionally exceeded guideline levels.

Hammerstone identified silt and soil introduction to streams as potential surface water quality impacts associated with construction of the Project. Other contaminants, such as nutrients and metals, were also identified as potentially being introduced. Hammerstone committed to employing appropriate technologies and best management practices, including sediment control techniques, to minimize erosion and silt loadings to streams during construction activities. Hammerstone concluded that no effects would occur to surface water quality from construction and other preparatory activities, with the implementation of appropriate mitigation measures.

Hammerstone stated that surface water quality might be altered as a result of changes in the hydrological regime in the ALSA (Section 3.5.1), including increases or decreases in channel flow and accompanied changes to various substance loadings. Hammerstone proposed to employ a number of standard mitigation measures to control sediment and runoff throughout the Project area and for the duration of Project operations. Hammerstone concluded that the magnitude of impact to surface water quality at the mouth of the proposed diversion channel would be within the range of perceived natural variability, would be local, and restricted to one drainage basin. The overall rating of impacts due to Project-derived loadings associated with changes to the hydrological regime was judged to be low.

Hammerstone stated that the proposed surface water collection and management system would not impact surface water quality. All potable water and sewage would be trucked into and out of the site, with no potential impact to the surface water systems.

Hammerstone estimated water quality in the proposed quarry lake based on observed annual concentrations for groundwater, average annual surface water flows, and surface water quality from historical data and data acquired during field surveys. Hammerstone assumed the lake would be fully mixed.

Hammerstone predicted the quarry lake water quality for the time of complete filling. Water quality of the lake and outflow water was expected to improve with time after the first release from the lake, as surface water inputs increase in significance relative to groundwater inputs and due to the flow through nature of the lake as it receives inputs from the upstream watershed. Elevated concentrations of some substances were expected at first release. Hammerstone presented predictions of the water quality within the quarry lake at equilibrium, well after the completion of filling. Hammerstone predicted that groundwater, although comprising a relatively minor percentage of the overall volume of water input to the lake, might be the major driver of water quality in the lake. Hammerstone expected total iron to exceed guideline levels in the surface water runoff entering the lake, would persist in the lake, and subsequently be above guideline levels in the lake outflow water. Hammerstone also predicted an exceedance of the guideline for copper in outflow water as a result of groundwater inputs. In all, Hammerstone noted potential guideline exceedances for iron, copper, aluminum, and selenium. According to Hammerstone, more complete water quality estimations were not made due to limitations of conclusions regarding reclamation techniques and design, which would be incorporated in a detailed reclamation plan during the life of the Project.

Hammerstone explained that historical monitoring had been conducted near the mouth of the Muskeg River. The river was generally well oxygenated at this location, with the exception of late fall and winter when anoxic conditions had been observed. Metal exceedances were consistent with the upstream location. Increased cadmium and mercury exceedances were documented and higher nutrient, nitrogen and phosphorus, concentrations were observed relative to the area surveyed along the border of the ALSA. Hammerstone concluded that no change in the concentrations for all selected substances was predicted at the mouth of the Muskeg River as a result of the Project or developments in the ARSA.

Hammerstone summarized that the water quality of the Athabasca River, at baseline, was characterized by relatively elevated nutrient concentrations and guideline exceedances for some metals. The Athabasca River, relative to the Muskeg River, had lower total dissolved solid and organic concentrations. Hammerstone stated that increasing nutrient and metal concentrations were observed with distance downstream. Guideline exceedances were predicted to occur for some metals within the ARSA. Hammerstone concluded that there would be no appreciable change in water quality in the downstream reach of the Athabasca River as a result of the Project or developments within the ARSA and that no cumulative effects on water quality were anticipated.

Hammerstone evaluated acid deposition effects on lakes within the AQRSA as part of the cumulative effects assessment. The assessment for the Project was based on comparisons between modeled air quality deposition predictions (Section 3.1) and critical load calculations for each lake. For lakes where the predicted potential acid input exceeds the critical load for the lake, the potential exists for lake acidification. Hammerstone stated that of the 257 lakes in the AQRSA for which chemistry data were available, 36 were identified as being moderately to highly sensitive to acidic input, with three being headwater lakes within the Muskeg River watershed in the ARSA. Of the lakes considered, 14 were predicted to experience acidic deposition above the critical load at baseline conditions. Hammerstone predicted that one lake would marginally exceed the critical load as a result of Project emissions, with the average change in acidification from baseline as a result of the Project approximately 1.9 percent of the critical load for all lakes. Hammerstone noted that the critical load for four additional lakes would be exceeded as a result of the cumulative effects assessment emissions, though none occurred within the ALSA. Hammerstone summarized that the cumulative effect of acid deposition on surface water quality due to planned projects was rated moderate.

Hammerstone stated that the majority of the potential surface water quality impacts related to the Project could be effectively managed through mitigation activities. These included:

- maintain a 200 m setback from the Muskeg River throughout the life of the Project;
- design and install culverts and road crossings in accordance with AENV Code of Practice (2000);
- sediment control techniques during construction and operations;
- use of sediment settling basins within the quarry, and external to the quarry pit;
- release of quarry water from ponds would continue to be subject to monitoring and compliance with applicable guidelines and approval conditions;
- channel banks would be stabilized to prevent erosion;
- construct and vegetate roadside ditches to collect and contain local road runoff; and,
- sewage would be trucked to an approved sewage treatment facility.

Hammerstone committed to water quality monitoring of potentially affected surface water systems through the life of the Project to assess the adequacy and performance of operational procedures and mitigation measures.

Hammerstone concluded that the overall effects of the Project on surface water quality were predicted to be low and localized.

3.5.2.2: Views of the Panel

The Panel accepts that Hammerstone conducted reasonable surface water quality assessments for baseline conditions, potential impacts from the Project, and potential impacts from reclamation activities. The Panel notes that typical direct and indirect effects to surface water quality from the Project include sediment loading, as well as dissolved ion, metal, nutrient, and organic loading. Impacts to surface water quality can occur from releases of water (e.g., during dewatering activities, from quarry runoff, from the quarry management pond, etc.), from construction and earthmoving activities, from changes to hydrologic characteristics, acidifying emissions, and by the creation of a quarry lake as part of the reclamation plan.

The Panel understands that the ALSA and ARSA were primarily used for the surface water quality assessments, while the AQRSA was used when examining the potential effects of acid deposition on lakes in the cumulative effects scenario. The Panel accepts that baseline conditions were assessed through the examination of historical data and by field surveys. The Panel finds that Hammerstone reasonably understands baseline surface water quality conditions and employed acceptable methodology. The Panel notes that surface water quality within the ALSA was characterized as being typical for the Muskeg River watershed and is typically influenced by flow through peat layers, resulting in relatively elevated levels of iron and total Kjeldhal nitrogen.

The Panel is aware that soil and suspended solids, including other contaminants such as nutrients and metals, are primarily of concern to surface water quality during quarry construction and preparation. The Panel accepts that with appropriate sediment control and other mitigation measures, these effects can potentially be adequately controlled. Similarly, proper mitigation techniques are required to be employed to control sediment runoff during operations, as committed to by Hammerstone.

The Panel finds that the creation of a quarry water management system, including a quarry water storage pond, and the planned use of this water for operations is reasonable. The Panel is unaware of any water quality requirements for the water to be used for operational processes, but encourages scheduled sampling and monitoring of collected water. Surface water quality should not be impacted by any wastewater created by activities at the site as Hammerstone has stated that all potable water and wastewater will be trucked in and out, with no releases.

The Panel notes that no exceedances of the interim sediment quality guidelines were observed and are not anticipated.

The Panel understands that water within the Muskeg Valley Quarry sediment settling system (wetland pond) is monitored before and during any planned releases, as per conditions of the Muskeg Valley Quarry approval. The Panel understands that release limits are set for TSS and pH, of which no exceedances have been observed, and that Hammerstone has analyzed for parameters in addition to those strictly tied to the approval. The Panel encourages Hammerstone to continue monitoring parameters in addition to those required in the approval, including nutrients, select metals, and hydrocarbon associated constituents.

The Panel finds that, due to relatively elevated natural levels of total organic and inorganic nitrogen and some observed seasonal variations in dissolved oxygen (ranging from near anoxic to anoxic conditions to greater than 100 percent saturation in both the drainages to the Muskeg River and the Muskeg River) during baseline assessments, additional nutrient loading to surface water bodies in both the ALSA and ARSA may impact surface water quality, particularly DO levels. The Panel is aware that Hammerstone presented observed dissolved oxygen concentrations that have been relatively low during low flow periods, suggesting organic loadings and respiration, and relatively high (exceeding greater than 100 percent saturation) during summer months, suggesting photosynthesis may be occurring. Additional inputs of nutrients and organic material as a result of the Project may amplify the fluctuations of dissolved oxygen concentrations (i.e., decreased minimum and increased maximum concentrations).

The Panel is aware that explosives to be used during quarrying activities may be nitrogen based, potentially providing an additional potential source of nitrogen to the water collection system. Considering these factors and the implications of dissolved oxygen on surface water quality (e.g., effects on pH, fish habitat), as a condition of approval, the Panel requires that Hammerstone monitor for nitrogen and phosphorus within the quarry water storage pond (settling pond) prior to and during water releases. Such monitoring shall be done to the satisfaction of Alberta Environment and appropriate limits for these parameters should be determined in consultation with Alberta Environment.

The Panel notes that a mass balance approach was utilized by Hammerstone for the estimations of water quality within the quarry lake following complete filling. The Panel accepts Hammerstone's assertion that water quality within the lake may be primarily controlled by groundwater inputs, although surface water inputs will be relatively greater in volume and that the water quality will improve over time due to the flow through nature of the lake as it receives inputs from upstream watersheds. The Panel notes that this is assuming groundwater and surface water quality will not change over time and is the same during reclamation as during baseline.

The Panel notes that Hammerstone anticipates some exceedances in surface water quality guidelines within the lake, and that these exceedances are interpreted to be a result of primarily natural conditions. Predictions of equilibrium concentrations were made for select parameters. Though considerable uncertainty remains about the overall surface water quality and conditions present in the lake following reclamation, particularly with respect to physical properties, nutrient concentrations, and the productivity of the proposed lake, the Panel appreciates the difficulties and uncertainties in predicting surface water quality of the lake following reclamation. Therefore, as a condition of approval, the Panel requires that surface water quality estimations and predictions of the quarry lake be reviewed and updated in conjunction and as part of the reclamation plan and design (i.e., every five years). Of particular importance will be surface water quality monitoring activities. The Panel requires monitoring of surface water quality during and following the lake-filling period to be included in the reclamation plan to validate predictions and provide guidance to changes in reclamation activities as required.

The Panel notes that impacts of acid deposition to lakes in the cumulative effects assessment were based upon initial deposition predictions made in the air quality section. The Panel is aware that some critical acid loads would be exceeded in the cumulative effects assessment as a result of air emissions, with the Project providing direct contributions. The Panel concludes that the contribution of the Project to this impact is not insignificant. The Panel accepts that a resolution to the issue of regional surface water acidification requires the concerted action of all project operators in the area. The Panel finds that Hammerstone has a responsibility to demonstrate a commitment to improve upon the projected results regarding generation and release of acidifying emissions. As a condition of approval, the Panel requires Hammerstone to actively participate in regional committees and associations that are working to understand the impacts of acidification and to reduce PAI emissions, particularly in areas where critical loads have been exceeded.

The Panel concludes that potential surface water quality impacts can be effectively managed through mitigation. As a condition of approval, the Panel requires Hammerstone to implement appropriate mitigation measures, including those committed to, into a surface water management plan. The surface water management plan must include implementation of a surface water quality monitoring program for potentially impacted locations within the ALSA and ARSA. The Panel requires this to include locations along the Muskeg River both up- and downstream of the Project, as done for the Muskeg Valley Quarry. The Panel also encourages Hammerstone to actively participate and coordinate activities with other regional initiatives, including the Regional Aquatics Monitoring Program.

3.6: Soils, Vegetation and Wetlands

3.6.1: Soils

3.6.1.1: Views of the Applicant

Hammerstone indicated that, within the terrestrial study areas, the following five issues related to potential Project impacts on soils, terrain and geology were examined:

- Soil quality characteristics
- Soil capability for forestry

- Soil suitability for reclamation
- Soil and wetland acidification
- Soil and terrain units (unique soil-landscape-vegetation relationships)

In order to conduct the evaluation of potential impacts, Hammerstone initially completed a baseline assessment of the existing soil and related resources.

Hammerstone noted that the preliminary information on the soil series and terrain types for the study areas was obtained from a review of available and published soil profile and mapping information. Hammerstone explained that the latter information included a reconnaissance level soil report prepared for the Alberta Oil Sands Environmental Study Area[1], as well as, reconnaissance and detailed level soils assessment reports prepared as part of the application for a number of major bitumen extraction projects[2] in the area. To enable more site specific soil classification and mapping, Hammerstone said field surveys (TLSA traverses, soil inspection pits, soil sampling/analyses) were conducted at an overall inspection density[3] of 1 site per 8.5 ha. It noted, however, that the inspection density was variable across the TLSA due to muskeg terrain. The Applicant stated that site attributes (e.g., slope class, landform, parent material, drainage, vegetative cover) and mineral/organic soil attributes (e.g., horizon thickness & sequence, texture, colour, calcareousness, von Post degree of decomposition for organic soils) were described and documented.

Terrain
Hammerstone stated that the TLSA composite maps of both the terrain units and the soil map units were developed employing a variety of datasets. Hammerstone said that the terrain of the TLSA consists predominantly of level to hummock and ridged landscapes on Pleistocene and recent deposits. It noted that organic bog and fen deposits are dominant in the TLSA (48 percent of the TLSA). With respect to the distribution of other terrain units in the TLSA, Hammerstone reported the following: glaciofluvial veneers (40 percent), fluvial and undifferentiated deposits (2-3 percent), natural lakes/flooded areas (0.6 percent) and Muskeg Valley Quarry footprint (8.2 percent).

Hammerstone indicated that the terrain units in the 1265 ha footprint of the Project would be essentially lost. It noted that partial mitigation of the loss of terrain would occur with the conservation and reclamation measures planned and the re-establishment of surface land forms and material conditions similar to pre-existing conditions. Hammerstone concluded that Project impacts would be high for terrain when rating the nature of change (magnitude, direction, duration), residual impacts and overall effects.

---

[1] Turchenek and Lindsay, 1982

[2] Examples: Syncrude Aurora (Landcare Research et al., 1996), Shell Jackpine Project (Shell Canada, 2002), Gulf Surmont, Petro-Canada Meadow Lake

[3] Soil Intensity Level 2 (detailed) = 1 inspection per 2-20 ha

Soils

Hammerstone said that the soil types in the TLSA and the TRSA were categorized according to the Canadian System of Soil Classification (Soil Classification Working Group, 1998). Within the study areas, Hammerstone identified the following soil series and soil variants:

- Gleysolic Order: 13 soil series/variants (Bitumount)
- Luvisolic Order: 10 soil series/variants (Fort)
- Organic Order: 10 soil series/variants (Hartley, McClelland, Mariana, Muskeg)
- Regosolic Order: 10 soil series/variants (Fort-XLZR)
- Non-soil: bedrock

Hammerstone identified mineral and organic as the two main categories of soils in the TLSA. It estimated that mineral soils (e.g., Luvisols, Gleysols) constitute 40 percent of the TLSA, while shallow organic soils, developed on bog or fen parent materials, cover 48 percent of the TLSA.

Hammerstone said that loss of soils cover in the TLSA was the major direct Project effect on soils. Within the TLSA, Hammerstone estimated that 26 percent of organic soils (peat), 40.6 percent of mineral soils (Luvisols, Bruinisols, Gleysols) and 0.4 percent of disturbed lands/water would be lost through disturbance in the 1265 ha Project area. Hammerstone stated that there was no mitigation for loss of soils cover but disturbed soils would be conserved and materials salvaged for use in the Project as required in the proposed Conservation and Reclamation Plan. Hammerstone indicated that soil materials would be used in reclamation of upland areas, as well as, in the construction of littoral and shore areas of the quarry lake. As with bedrock geology and terrain, Hammerstone concluded that the Project impacts would be high for soils when rating nature of change (magnitude, direction, duration), residual impacts and overall effects.

Soil Quality and Characteristics

Hammerstone reported that soil quality and characteristics related to the following key considerations were also assessed according to recognized protocols[4]:

- reclamation success,
- management measures required to maintain soil quality during long-term storage,
- potential to support re-vegetation and forestry,
- susceptibility to wind and water erosion, and
- sensitivity to potential acid input (PAI).

---

[4] Examples: Soil Quality Criteria Relative to Disturbance and Reclamation (Alberta Soil Advisory Committee, 1987), Land Capability Classification for Forest Ecosystems in the Oil Sands (Leskiw, 1996&1998), Universal Soil Loss Equation (Tajek et al., 1985), Critical loads for organic soils in Alberta (Turchenek et al., 1998)

When evaluating Project effects, Hammerstone conservatively assumed that all the direct impacts of the Project to terrain units and to soil map units, occur at one time. Hammerstone said the impacts were quantitatively estimated by GIS procedures.

Within the Project disturbance area, Hammerstone stated that the mineral soils (Bitumount, Fort) rate as best suited for reclamation purposes. It said that the upper lifts (UL) of these soils are rated as Fair but the lower lifts (LL) are rated as Poor due to the presence of bedrock close to the surface. Hammerstone explained that any peaty surfaces associated with these mineral soils could be admixed into the topsoil during salvage or salvaged separately. Hammerstone indicated that the Organic soils (Hartley, Marianna) are rated as 'O' in the UL and Fair in the LL. Hammerstone concluded that the entire disturbance area has surface soils suitable for reclamation. For subsoils, Hammerstone estimated that just over one half the land area to be disturbed, is of value in reclamation with the remainder consisting mainly of bedrock. Hammerstone emphasized the importance of handling and managing soils during salvage and stockpiling to preserve soil quality and suitability for reclamation.

Hammerstone rated the peak impacts of the Project on reclamation suitability of soil as low. With proper placement of reclamation materials, Hammerstone concluded that residual impacts would also be low.

Hammerstone indicated that a Land Capability Class for Forest Ecosystem in the Oil Sands (LCC) of 4 is the highest in the TLSA, occupying 3 percent of the area and associated with the Fort soil map units. Hammerstone said that soils with a Class 5 LCC rating occupy about 88 percent of the TLSA. Hammerstone noted that these soils are severely limited by low moisture holding capacity, low nutrient status or a combination of other soil factors.

Hammerstone predicted that the Project impacts would reduce or, in some cases, improve the overall capability of soils for forestry. Hammerstone said that the salvage of organic soils during site construction provides a source of organic material (peat) for use in soil amelioration and site reclamation. Hammerstone noted that the mixture of salvaged peat materials with mineral topsoil would likely improve the quality of salvaged topsoil and therefore improve the LCC of the reclaimed soil. Hammerstone concluded that the Project effects on LCC and loss of land area would be equivalent to that for soil loss. However, Hammerstone predicted that Project impacts would be low for those areas that can be returned to forest growth.

Hammerstone reported that most soils in the TLSA were rated as Slight, in terms of water erosion risk and Low (High)[5] for susceptibility to wind erosion. Hammerstone noted that Organic soils were generally regarded as having a slight water erosion risk due to their level topography. It indicated that most mineral soils in the TLSA had permeable sandy surface layers and therefore, were not readily erodible. Hammerstone said that the rating for wind erosion reflected the predominance of soil with peat surfaces in the TLSA. It explained that the latter soils were at low risk of wind erosion when wet but at high risk when dry, as a consequence of drainage or surface stripping. Hammerstone noted that the coarse-textured mineral soil surfaces were also prone to wind erosion.

---

[5] Erosion risk rating: Low (High) – Low, when organic soils cleared and in normal moist condition. High, if organic soils drained and surface conditions dry

Hammerstone predicted the magnitude of Project effects on soil erosion risk to be low during construction and decommissioning phases of the Project and negligible during the operation phase. Hammerstone rated the direction of Project effects on this soil attribute to be adverse to negative. It reported that all evaluated Project impacts on this soil attribute were reversible.

Hammerstone stated that recognized protocols[6] were adopted and implemented to rate the soil series in the TLSA for sensitivity to acidification. Hammerstone said that Moderate, Moderate (Sensitive)[7], Moderate (Low) and Moderate-Not Rated classes of soil sensitivity to acidification predominated in the TLSA, accounting for 58 percent of the area. Hammerstone explained that much of this area consists of the Organic Marianna soils and the Fort and Dalkin mineral soils. Hammerstone reported that 32 percent of the area consists of Low and Low (Moderate) sensitivity soils (Organic Hartley). It estimated that the Sensitive (Moderate) category of sensitivity (0.4 percent) consists mainly of coarse-textured Mildred soils, which are characterized by low surface soil pH and low acid buffering capacity.

Hammerstone reported that the potential effect of acidifying inputs from the Project on non-disturbed soils within the TLSA was assessed by considering the critical loads of TLSA soil series determined by modeling[8]. Hammerstone stated that the critical loads are based on different critical soil chemical values such as exchangeable base saturation, base cations to aluminum ratio or base cations to hydrogen ratio. Hammerstone said these critical soil chemical values are threshold criteria, above or below which further changes due to acidifying inputs to the soil would be considered unacceptable. Hammerstone noted that critical loads are intended to ensure that the magnitude of a critical soil chemical value is not reduced to more than 75 percent of its original value.

Under baseline conditions, Hammerstone indicated that most of the soils in the TLSA receive acidity at levels exceeding the critical loads of these soils. Hammerstone predicted that with the Project, an additional 2.6 percent of the soils in the TLSA would experience acidifying deposition greater than the assigned critical loads. Hammerstone rated the Project impact on acidification of soils in the TLSA not removed by development, as moderate based on magnitude, direction, duration, frequency and confidence of the predicted change. Hammerstone rated the residual Project impact as low based on the view that soil acidification effects are considered reversible. Hammerstone said that acidified soils are predicted to return to initial conditions due to internal mechanisms such as the return of base cations by mineral weathering and nutrient cycling. However, Hammerstone noted that confidence regarding prediction is low because soil acidification and acid buffering processes, especially over the long term, are not well understood.

---

[6] Examples: "Soil Sensitivity to Acid Deposition and the Potential of Soil and Geology to Reduce the Acidity of Acidic Inputs" (Holowaychuk, N. & R.J. Fessenden. 1987. Alberta Research Council. Earth Sciences Report 87-1. Edmonton, AB.), "Application of Critical, Target, and Monitoring Loads for the Evaluation and Management of Acid Deposition" (CASA and ENV). 1999. Target Loading Subgroup. Edmonton, AB.)

[7] Rating in brackets refers to subordinate soil series/variant in the soil map unit

[8] Abboud, S.A. et al. 2002. Critical Loads of Acid Deposition on Soils in the Athabasca Oil Sands Region, Alberta. NO_x-SO_x Management Working Group, Cumulative Environmental Management Association. Alberta Research Council, AMEC Earth & Environmental and University of Alberta, Edmonton, AB.

Cumulative Effects Assessment

Hammerstone stated that the Project represents about 0.8 percent of the TRSA. Hammerstone acknowledged that the loss of soil cover, bedrock materials and surficial geological materials through Project development would occur. However, Hammerstone concluded that, with respect to the TRSA, the overall significance of these impacts was low when considering the magnitude of this Project in relation to other major oil sands projects in the TRSA and when considering the planned mitigation and reclamation measures for the Project.

Hammerstone judged the overall cumulative effects of the Project on TRSA soils suitability for use in reclamation as neutral to positive. It based this conclusion on the fact that predominantly wetland soils (peat) were to be used as a soil amendment in the reclaimed areas to improve the capability of the reclaimed soil to support forest growth.

Hammerstone indicated that land capability for forestry within the TRSA was linked to reclamation suitability of soil. Hammerstone anticipated a slight improvement in soil capability for forestry in the TRSA as LCC Class 5 soils would be slightly improved by peat admixing. Hammerstone judged the overall significance of Project impacts in this regard to the TRSA as low.

Under baseline conditions, Hammerstone reported that 66,248 ha of soils in the TRSA were predicted to experience potential acid input (PAI) levels that would exceed their critical loads. Hammerstone stated that the Project would increase this statistic by 3,482 ha (2.2 percent TRSA) and other future projects would add 2,188 ha (1.4 percent TRSA). Hammerstone rated this predicted impact and increase in TRSA soil acidification as moderate. Hammerstone also rated the contribution of the Project to potential soil acidification in the region as moderate. However, because the assessment was based on modeling, Hammerstone rated the confidence in the assessment as low.

3.6.1.2: Views of the Panel

The Panel notes that the mitigation measures proposed by Hammerstone for the impacts of the Project on soil resources are closely linked to the Conceptual Conservation and Reclamation Plan (C&R). Consequently, the Panel anticipates that amendments to the C&R may result in subsequent changes in the mitigation measures for Project impacts. In addition, the Panel concludes that the uncertainties related to the C&R (Section. 4.2) translate directly to uncertainties in the effectiveness and long-term success of the mitigation measures proposed for the Project impacts on soil resources.

The Panel finds that Hammerstone has not completed and presented a reassessment of soil resources in response to the latest amended C&R that now involves a shallow quarry lake. Therefore, as a condition of approval, the Panel requires that Hammerstone complete and present to AENV's satisfaction, a reassessment of soil resources in response to the latest C&R that now involves a shallow quarry lake.

As a condition of approval, the Panel also requires Hammerstone to assess, document and accommodate any changes to the mitigation measures for Project impacts to soil resources, arising from the ongoing 5 year updates and changes to the original C&R.

The Panel notes that Hammerstone judged the Project contribution to potential TRSA soil acidification as moderate, resulting in an estimated 2.2 percent increase in TRSA soils receiving PAI levels exceeding their critical acidifying loads. The Panel finds that the contribution of the Project to this adverse impact is not insignificant. The Panel accepts that a resolution to the issue of regional soil acidification requires the concerted action of all project operators in the area. However, the Panel concludes that Hammerstone has a responsibility to demonstrate, meaningfully, a commitment to improve upon the projected results regarding generation and release of acidifying emissions. As condition of approval, the Panel requires Hammerstone to participate actively in regional committees and associations that are working to understand the impacts of acidification and to reduce PAI emissions, especially in regional areas where critical loads have been exceeded. Hammerstone will be required to mitigate air emissions, in part, by a phased BATEA approach to the installation and operation of limestone processing equipment at the Project (Section 3.1.2). The Panel expects Hammerstone, in implementing this technological approach to the mitigation of air emissions, to effectively control and minimize the point source(s) generation and release of PAI emissions from its operations.

The Panel concurs with Hammerstone that salvaged topsoil and subsoil are a valuable resource for reclamation. While the sale of the excess salvaged soils to regional operators may be an option, the Panel concludes that this alternative should only be considered after the reclamation needs of disturbed areas resulting from the Project have been fully satisfied. As stated in Section 4.2, the Panel requires the placement of a 50 cm depth of topsoil cover to ensure the establishment of self-sustaining upland forest ecosystem in a setting where soil moisture is likely to become a critical factor for long-term success.

3.6.2: Vegetation and Wetlands

3.6.2.1: Views of the Applicant

Hammerstone Corporation (Hammerstone) stated that an impact assessment on vegetation and wetlands was conducted by mapping and documenting vegetation and wetland resources that existed prior to development of the Hammerstone Quarry Project (the Project), followed by an assessment of local project related impacts, and regional cumulative effects on vegetation and wetlands as a result of the Project. Hammerstone outlined potential direct disturbances and indirect effects that the Project could have on vegetation and wetlands, and addressed issues relating to the Project as identified through the evaluation of Project components and input from other sources, including stakeholders.

Hammerstone assessed individual vegetation and wetland characteristics to determine maximum potential Project impacts that might occur and reclamation scenario residual impacts in the Terrestrial Local Study Area (TLSA) relative to baseline conditions. Vegetation and wetland resources within the TLSA that were determined to be impacted by the Project were subsequently assessed to determine the contribution of the Project to regional cumulative effects within the Terrestrial Regional Study Area (TRSA). Hammerstone stated that the assessment focused on uncommon vegetation systems (those that covered ≤1 percent of the TLSA).

Hammerstone outlined the methods used to conduct the impact assessment. A review of existing information was conducted. Field surveys, comprised of detailed vegetation plot surveys, rare plant and rare plant community surveys, and a traditional ecological knowledge field visit, were completed to determine ecological land classifications, the presence of rare plant species or plant communities, and for use in vegetation and biodiversity analysis. Hammerstone selected a set of vegetation and wetland parameters to evaluate potential Project impacts on vegetation resources. Parameters included vegetation types (ecosite phases and disturbances), wetlands, old growth forests, riparian habitat, landscape diversity, vegetation species richness, rare plant species and potential, traditional-use plants, air quality and emissions, groundwater drawdown, and non-native species and weeds. Hammerstone stated that the cumulative effects assessment included vegetation disturbances, landscape diversity, and air emissions.

Hammerstone determined areas and percent distribution of each ecosite phase and disturbance class for vegetation types at baseline conditions, at full Project development, and reclamation scenarios. Ecosite phases were further divided into uplands, lowlands, and open water groups for some analyses. Hammerstone stated that at baseline, approximately 90 percent of the TLSA (total area of TLSA was 2,689 ha) is undisturbed, comprised of 41 percent uplands, 49 percent lowlands, and 1 percent open water. The remaining 10 percent of the baseline TLSA was classified as disturbed classes, with 8 percent being the approved Muskeg Valley Quarry and 2 percent other disturbances. Hammerstone stated that the Project would increase disturbances in the TLSA to 46 percent, with impacts among individual ecosite phases ranging from 0 to 100 percent loss. Hammerstone estimated that following reclamation approximately 98 percent of the TLSA would be undisturbed or natural, comprised of 47 percent uplands, 32 percent lowlands, and 19 percent open water. Approximately 2 percent would be disturbed class. Hammerstone summarized with high confidence that at full Project development, impacts to vegetation types would be high in magnitude, negative, local, and long term. Hammerstone predicted with moderate confidence that following reclamation, residual impact magnitudes were high in both the positive and negative directions, depending on individual ecosite, and that the overall residual impact to natural areas would be moderate and positive in direction.

Hammerstone stated that the Alberta Wetland Inventory classification system was used to divide wetlands into five main classes, each further subdivided into types dependent on vegetative and other ecological characteristics. The baseline area and percent distribution of each wetland type within the TLSA was calculated and compared with the distribution of wetland types at full Project development and with the reclaimed scenario. Hammerstone stated that at baseline, ten wetland types occurred, covering approximately 52 percent (1,397 ha) of the TLSA (2,689 ha). The Project would result in a loss among all wetland types of 59 percent, ranging in impact from 0 to 100 percent. Hammerstone predicted that following reclamation, wetlands would cover approximately 890 ha, an overall reduction of 36 percent compared to baseline and that most individual wetland class types would be reduced. Hammerstone rated impacts to wetland areas, with high to moderate confidence, as high, negative, local, and long term at full project development and high to moderate for the reclamation scenario.

Hammerstone outlined that old growth forests were identified in the TLSA by species-specific age definitions for forested ecosite phases based on dominant tree species classes. Areas of old growth forests were compared between baseline and Project development scenarios, with only the potential impacts and changes as a result of the Project being considered. Hammerstone stated that old-growth forests represented 5 ha (0.2 percent) of the TLSA at baseline, which would be further reduced to 1 ha (by 80 percent) with Project development, though the total area affected would remain relatively low. Hammerstone concluded that because of the relatively low confidence in potential impacts to old-growth forests and the relatively low area affected, the impact rating for the Project and residual cases were considered to be moderate.

Hammerstone determined the area of each ecosite phase in riparian areas and assessed impacts to riparian areas by comparing the baseline case to the full Project development and reclamation scenarios. Riparian habitat in the TLSA was determined by creek, river, and waterbody buffering using riparian set-back widths of 100 m around lakes, 50 m on each side of major rivers, and 30 m on either side of creeks and small rivers. Hammerstone stated that riparian habitat occurred on approximately 8 percent (202 ha) of the TLSA at baseline. The Project would result in a 32 percent overall loss of natural riparian habitat in the TLSA, including upland and lowland riparian classes and lakes and flooded areas. Hammerstone rated this impact as high magnitude, negative in direction, and long term in duration. Hammerstone outlined that under the initial reclamation scenario, a relatively large area of new riparian habitat would be created adjacent to the quarry lake. Hammerstone predicted a total increase of 369 percent in riparian habitat, compared to baseline, characterized by increases of 11 percent to riparian uplands, 190 percent to riparian lowlands, and 3,315 percent to open water areas. The residual impact rating was considered low and positive, with moderate confidence.

Hammerstone stated that three landscape diversity metrics, density of linear disturbances, patch number and size, and anthropogenic edge to area ratio, were used to describe fragmentation in the TLSA. Baseline conditions were compared to Project development and reclamation conditions. Hammerstone stated that linear disturbances totaled 1.83 km/km^2 at baseline, which would be reduced to approximately 0.95 km/km^2 as a result of Project development, and would be approximately 1.22 km/km^2 following reclamation. This was rated as a high positive impact during operations, though it represents a change from one type of disturbance to another, and rated as a low residual impact. Hammerstone determined that the TLSA was not extensively fragmented at baseline and that there were 617 patches of natural ecosite phases. Development of the Project would restructure the patches, creating a large disturbed patch in the centre of the site and result in a loss of natural patches within that area. Hammerstone concluded with good confidence that the impacts to patches in the TLSA would be high in magnitude, negative, and long-term in duration. Hammerstone expected that reclamation would return some of the patches lost during Project development, and that the total number of ecosite phase patches would remain lower than at baseline by 19.4 percent and mean patch size would increase, suggesting the reclaimed habitat would be less fragmented. The residual impact rating was considered to be low with good confidence. Hammerstone stated that anthropogenic edge to area ratio among ecosite phases ranged from 0.0 to 8.62 km/km^2 at baseline, would increase 35 percent over baseline values during Project development, and would decrease from baseline by approximately 8 percent as a result of reclamation activities. Hammerstone concluded with good confidence that impacts to ecosite phases from anthropogenic edge to area ratio would be high in magnitude, negative in direction, and long-term. The residual impact was considered low.

Hammerstone stated that to estimate and rank the relative species richness of each ecosite phase, three estimates, total richness, mean richness, and unique richness, were combined. Expected and potential impacts to species richness classes and individual species were assessed by comparing ranked areas for the Project and reclamation scenarios to ranked areas for baseline conditions. Hammerstone stated that at baseline, 30 percent of the TLSA was covered by ecosite phases rated high in species richness, 45 percent covered by areas rated medium, and 15 percent covered by areas rated low. Project disturbances would decrease species richness by 49 to 52 percent among ranked classes and the total area of all ranked species richness classes would remain lower than baseline following reclamation. Hammerstone concluded that Project impacts to ranked species richness areas would be high in magnitude and that residual impacts would be moderate to high following reclamation. Hammerstone outlined that all areas impacted by development would result in potential losses of species, which could include the loss of species unique to each ecosite phase. Hammerstone determined the risk of losing species in the TLSA as being moderate for all classes during Project development and that the risk may be partially, but not totally, mitigated following reclamation. Hammerstone concluded that the overall assessment rating for impacts to species was low to moderate in both the full Project impact and residual impact assessments.

Hammerstone stated that assessments of rare plant species and rare plant species potential were made using information obtained during field surveys and from other available records. Hammerstone explained that impacts to rare plant habitat and potential to individual species were assessed through comparison of ranked rare plant potential areas in each the Project and reclamation scenarios to ranked areas in the baseline. Hammerstone stated that seven rare plant species were observed within the TLSA, associated primarily with fens, marshes, and flooded areas. At baseline, high rare plant potential habitat covered approximately 8 percent of the TLSA, 38 percent was ranked medium, 44 percent low, and 10 percent of the area was ranked as having no potential for containing rare plants. Hammerstone showed that all individuals, except for two instances, would be removed as a result of the Project. High and low rare plant potential areas would be decreased 20 to 61 percent by the Project. Hammerstone considered these impacts to be high in magnitude, local, and long term, with good confidence. Hammerstone proposed that losses might be mitigated through seed collection or transplanting individuals prior to Project development, which might require an additional survey prior to development activities. Hammerstone predicted that there would be a shift from medium potential to high potential rare plant habitat as a result of reclamation activities, a high magnitude residual impact, and that the overall residual impact rating on rare plant potential was considered low.

Hammerstone outlined that impacts to capability and berry cover for traditional-use plants were assessed by comparing ranked areas in the Project and reclamation scenarios to ranked areas in the baseline scenario. Hammerstone stated that at baseline, traditional-use plant capability ranked high for 61 percent of the TLSA, 22 percent ranked medium, and 6 percent ranked low. Project disturbances would result in decreases among high to low traditional-use capability classes ranging from 43 to 68 percent. Hammerstone considered the Project impacts, with good confidence, as high in magnitude, negative, local, and long term. Residual impacts were considered to be moderate to high in magnitude.

Hammerstone determined potential impacts of air emissions on vegetation by evaluating a baseline air quality case and a Project air quality case within the TLSA, relying on air quality analyses, estimates, and predictions (Section 3.1). Confidence in the assessment of air quality impacts on vegetation impacts was relatively low. Hammerstone stated that there is uncertainty whether an exceedance in an air quality guideline would affect plant species and that the overall confidence in the assessment of potential air quality impacts on vegetation is generally considered to be low. Hammerstone expected no impacts to vegetation due to sulphur or nitrogen oxides generated by the Project. Hammerstone assessed potential impacts of eutrophication in the TLSA by examining the difference in nitrogen oxide deposition rates among areas of ecosite phases between baseline and Project impact scenarios. Hammerstone stated that eutrophication might be a relatively high magnitude local effect, but that actual impacts to vegetation could not be confidently predicted.

Hammerstone identified ecosite phases potentially sensitive to acidification and assessed potential impacts by determining the area of each ecosite phase occurring on soils that exceeded the deposition load assigned to its level of sensitivity. Hammerstone predicted the overall impact rating for impacts to vegetation on sensitive soils at risk to acidification to be moderate.

Hammerstone stated that dust impacts from the Project were assessed qualitatively based on the potential for increase in dust as the quarry area is developed. Hammerstone concluded that dust impacts would increase over baseline levels as a result of the Project, but the magnitude of impact due to dust would be low, local, and is medium term in duration. The confidence level for the assessment was low.

Hammerstone concluded that there would be no potential impact to wetlands by groundwater drawdown, as there was no expected significant groundwater drawdown in the TLSA.

Hammerstone stated that the potential impact to ecosite phases due to weed establishment that might occur as a result of the Project was qualitatively assessed based on invasive characteristics and status of observed weed and non-native species, the susceptibility of ecosite phases to invasion and establishment of weeds, and by change in the levels of disturbance adjacent to ecosite phases. Hammerstone stated that approximately 12 species of weeds and non-native plants were observed in the TLSA at baseline, with most associated with fens, flooded areas, and disturbed areas. Hammerstone noted that if weeds are controlled during development of the Project, the invasion of weeds into natural adjacent areas would be limited. Hammerstone concluded with high confidence that the potential impact of weed colonization would be low to moderate with no mitigation. With extension of the weed program currently employed within the Muskeg Valley Quarry to the Project, the residual impacts were thought to be reduced to low. The potential impacts of weeds and non-native vegetation were anticipated to be local in extent and potentially long term in duration.

Hammerstone stated that the TRSA is primarily composed of spruce/fir forest, treed wetlands, and existing disturbances, with moderate amounts of pine forest, deciduous forest, mixedwood forest, open wetlands, and burned areas. Hammerstone estimated that direct Project impacts would range from 0 to 1.5 percent on regional Alberta Ground Cover Classification classes. The overall vegetation disturbance regional impact was rated moderate and long-term in duration, with good confidence in the assessment. Hammerstone outlined that the Project contribution to disturbed areas in the TRSA would be approximately 2.3 percent, considered a moderate regional cumulative effect. The overall regional impacts due to linear disturbances were considered low, as the Project is expected to reduce linear disturbances. Hammerstone stated that the Project contribution to regional cumulative effects on linear density would be moderate and positive, while the regional cumulative effects as a result of the Project on patch size and number would be moderate and negative.

Hammerstone stated that the assessment of air quality impacts on a regional scale was based on results of regional air quality modeling and was subject to a number of assumptions and uncertainties. No exceedances were expected for nitrogen and sulphur oxides as a result of the Project and no regional cumulative effects were expected. Hammerstone explained that an increase in the area of sensitive soils to receive acid deposition as a result of the Project would result in negative, high magnitude Project related regional cumulative effects. Confidence in the assessment was relatively low, with a high degree of uncertainty. Hammerstone expected the regional overall impact of nitrogen deposition in vegetation and potential eutrophication as a moderate impact as a result of the Project.

Hammerstone stated that the Project has been designed to minimize effects where possible, including avoiding disturbances in sensitive areas, establishing a setback of 200 m along the Muskeg River, and establishing an archaeological exclusion zone defined as the Quarry of the Ancestors. Mitigation measures suggested for minimizing losses of vegetation communities primarily involved reclamation and revegetation activities and would also focus on protection of vegetation and wetlands outside the quarry development. Hammerstone proposed to relocate rare plant species and collect seeds from rare plants to mitigate Project impacts to these species and for potential re-establishment during reclamation activities. Hammerstone stated that the weed management program currently operated at the Muskeg Valley Quarry would be extended to include the Project and that weed control measures would be undertaken when required.

Hammerstone committed to continued involvement in a number of ongoing and future regional monitoring programs and research initiatives.

3.6.2.2: Views of the Panel

The Panel finds that reasonable vegetation and wetlands baseline and impact assessments were conducted by Hammerstone for the proposed Project. The Panel acknowledges that the Project will have a direct and significant effect on vegetation and wetland resources, particularly within the Terrestrial Local Study Area (TLSA). The Panel considers the effects and impacts, if properly managed and accounted for, appropriate and reasonable for the Project development.

The Panel notes that baseline assessments, Project development and operation impact assessments, and residual effects assessments were conducted for specific vegetation and wetland characteristics. Individual vegetation and wetland characteristics that were considered to be impacted for the Project and residual effects scenarios within the TLSA were subsequently assessed to determine the contribution of the Project to regional cumulative effects within the Terrestrial Regional Study Area (TRSA).

The Panel accepts that appropriate and comprehensive assessment methods were employed, including a review of available literature and field surveys. The Panel finds that the vegetation and wetlands baseline scenario was well characterized, with reasonable estimations made of Project disturbances for each vegetation and wetland characteristic assessed as part of the Project development scenario.

The Panel is aware that during Project operations all vegetation and wetlands within the footprint of the excavation area will be removed, including associated changes to biodiversity, fragmentation, and vegetation species composition. While the Project will remove some fragmentation and linear disturbances within the TLSA, it is a change in disturbance type and is considered by the Panel a significant disturbance.

The Panel notes that a significant portion of wetlands existing during baseline conditions will be removed as a result of the Project. Although not isolated to the proposed Project, wetland loss is a concern in Alberta. The Panel understands that the reclamation plan includes the re-establishment of some wetland areas, which could be expected to increase in area as a result of the revised reclamation plan, with a shallower more diverse lake and wetland area. Although this is positive in returning a greater area of wetlands to more natural conditions, considerable uncertainties remain with respect to wetland reclamation and revegetation, which is potentially a concern. The Panel requires, as a condition of approval, ongoing monitoring and assessment of wetland reclamation success, to be included in the five year updates to the reclamation plan. The Panel notes efforts made by Hammerstone in the Project to minimize the loss of wetlands. The Panel accepts that the amount of riparian vegetation will significantly increase as a result of the reclamation plan as presented as residual impacts by Hammerstone.

The Panel notes that, although comprising a relatively small portion of the TLSA, almost all old growth forests within the TLSA will be removed as a result of the Project. The Panel appreciates that predicting the development of old growth forests and potential natural or non-natural disturbances to such communities is difficult. Some current forest stands may become old growth within a relatively shorter period than that suggested by the ultimate reclamation timeline presented, while others may be removed through fire or other disturbances.

The Panel understands that almost all rare plant species will be removed as a result of the Project and that additional potential rare plant habitat may exist following reclamation. The Panel acknowledges that Hammerstone would be amenable to mitigating rare plant and traditional-use plant loss through seed collection, cuttings, or transplanting individuals prior to Project development and that this may require an additional rare plant survey prior to construction activities. The Panel endorses Hammerstone's commitment to mitigate the loss of rare and traditional-use plant species through seed collection, cuttings, and transplanting prior to Project development. The Panel also encourages potential inclusion of these species as part of revegetation activities during reclamation of the site in areas considered high rare and traditional-use plant potential as part of the residual impacts assessment.

The Panel agrees that it is difficult to predict impacts on vegetation and wetlands as a result of air emissions and deposition of NO_x, SO_x, nitrogen, dust, and acid inputs. The Panel notes that the assessment of air emission impacts on vegetation and wetlands was conducted based on initial air emission estimates, ambient air quality concentration predictions, and air dispersion modeling as presented in the original environmental impact assessment, and were not adjusted following additional air modeling exercises. The Panel notes that although the updated air emission and ambient air quality concentration estimations and air dispersion modeling exercises predicted slightly different values than that used in the assessment, confidence in the assessments of potential impacts on vegetation and wetlands were relatively low and impacts were predicted to be relatively low.

The Panel is aware that potential weed issues, including introduction and persistence of invasive species, may exist as a result of disturbances and activities associated with the Project. The Panel encourages Hammerstone to maintain and expand the weed program currently employed at the Muskeg Valley Quarry to include the Project area and to remain vigilant in controlling introduction and invasion of weed species. The Panel accepts that with proper mitigation, weed establishment and spread can be effectively controlled.

The Panel finds that potential Project related regional cumulative effects on vegetation and wetlands cannot be considered negligible, though they are relatively small in scale compared to other developments within the area. While this does not exclude consideration of potential impacts as a result of the Project, the disturbances are considered by the Panel as being reasonable on a regional scale. Nevertheless, the Panel finds that Hammerstone has a responsibility to demonstrate a commitment to improve upon the projected results regarding impacts to vegetation and wetland resources. As a condition of approval, the Panel requires that Hammerstone actively participate in regional committees and associations that are working to understand and minimize regional impacts to vegetation and wetlands.

The Panel has some difficulty in evaluating and determining the overall impacts to vegetation and wetlands because of some uncertainties associated with the assessment. New information and changes to controlling factors have been updated relative to the initial vegetation and wetland assessment, particularly with respect to the overall reclamation plan of a shallow lake and air quality modeling, which was not updated in the vegetation and wetlands assessments. While the Panel does not anticipate significant increases in negative effects due to these changes, it does make the evaluation of the overall impacts relatively more difficult. As a condition of approval, the Panel requires that the residual impact assessment be updated during each five year review of the reclamation plan.

Much of the reclamation plan and residual effects assessments on vegetation and wetlands were reliant on a proper revegetation plan, which was not presented in detail, and was considered on an ecosite phase basis. The Panel understands that the assessments and conclusions were based on the initial reclamation plan (i.e., a deep quarry lake) and not on the currently proposed relatively shallower lake. The Panel notes that the shallower lake will have different effects on both vegetation and wetlands community structure and establishment within the TLSA, resulting in different percentages of vegetation communities and particular species present than that presented in the initial assessment. The existence of a shallower lake and/or greater wetland areas may potentially promote a closer semblance to pre-disturbance vegetation and wetland communities, but the Panel cannot conclude this based on the presented assessments.

The Panel notes that it is not well known whether individual species and plant communities will successfully re-establish as a result of reclamation activities, particularly those present in wetland communities. While ecosite phases, upland, lowland, and open water classifications were used in the residual impact assessments, it is uncertain whether the same species diversity and vegetation communities will re-establish post-revegetation. The Panel also notes that there are some uncertainties with the potential success of wetland reclamation in the region. The Panel understands that individual effects of air emissions are also not well understood as to potential effects on vegetation and wetland communities.

The Panel finds that continual vegetation and wetland monitoring and updated assessments of Project related and cumulative effects are required during and after Project related operations because of the related uncertainties, to validate predicted impact magnitudes, and to evaluate mitigation activities. As a condition of approval, the Panel requires that Hammerstone continually update the revegetation portion of the reclamation plan every five years, as part of the reclamation plan updates, using the best available knowledge and techniques developed over time (as stated in Section 4).

The Panel supports Hammerstone in being an active participant in regional and local groups and initiatives such as the Sustainable Ecosystems Working Group of the Cumulative Environmental Management Association, the Alberta Biodiversity Monitoring Program, the Biodiversity Sub-group of the Reclamation Working Group, the Wood Buffalo Environmental Association, and the Regional Aquatics Monitoring Program.

3.7: Wildlife and Fisheries

3.7.1: Wildlife

3.7.1.1: Views of the Applicant

Hammerstone considered the following wildlife impacts in its impact assessment:

- Direct effects on wildlife due to clearing of vegetation, changes in surface water conditions, and altered access associated with the quarry development;
- Changes in wildlife habitat use adjacent to the quarry as a result of sensory disturbances;
- Disruption to wildlife movement patterns and habitat linkage corridors; and,
- Direct and indirect wildlife mortality as a result of increased traffic.

Hammerstone indicated that it was not feasible to assess potential Project impacts on all species in the study area. It focused on priority species selected by the Cumulative Effects Management Association (CEMA) because these species were considered sensitive to human activities, important for traditional use, or because of regional management concerns. The CEMA priority species considered included the pileated woodpecker, moose, fisher, Canada lynx, boreal owl, black bear, and great grey owl. In addition to the eight priority CEMA species, Hammerstone also selected the northern long-eared bat for assessment because it is known to occur in the Project area and is considered "may be at risk" by Alberta Sustainable Resource Development. The Applicant discussed potential Project impacts on other wildlife present in the Project area in terms of species groups such as large carnivores, ungulates, terrestrial fur bearers, semi-aquatic mammals, waterfowl, upland game birds, raptors, reptiles, amphibians and passerine birds.

Hammerstone indicated that wildlife field studies were conducted within the Terrestrial Local Study Area (TLSA). According to the Applicant, the TLSA included the Project area where disturbances would have an immediate effect on wildlife and the area around the Project area where wildlife would be indirectly impacted by noise and dust deposition which could alter habitats. It used the Terrestrial Regional Study Area (TRSA) for conducting a cumulative effects assessment for wildlife resources. The TRSA encompassed all known and future land uses that have the potential to impact wildlife.

Hammerstone stated that the Project nature and intensity of development would vary for the life of the Project. In addition, it stated that Project related impacts would vary because of progressive site reclamation. To address the dynamic effects of the Project, Hammerstone indicated that it assessed impacts on wildlife resources under peak Project operating conditions. The Applicant also assessed residual (i.e., after reclamation) impacts on wildlife.

The Applicant indicated that information for the wildlife impact assessment was obtained from:

- Field studies conducted in 2003 and 2004 in support of the Muskeg Valley Quarry Project. The field studies included owl call paybacks, amphibian surveys, snake surveys, songbird point counts, winter track counts, a browse and pellet group count, goshawk call playback, and bat surveys.

- Environmental Impact Assessments (EIAs) submitted in support of the application process for oil sands projects of relevance to the Project area.
- Syncrude Canada Ltd. and Husky Energy Inc. according to an information sharing agreement. This information not only included information on wildlife in the Syncrude and Husky local study areas but also a regional area which allowed for the study of wildlife in undisturbed areas.

Hammerstone indicated that it used habitat modeling for the selected wildlife species to identify preferred habitats (based on vegetation and terrain characteristics) and the ability of the post-mining landscape to support these species. The Applicant stated that habitat models based on field data were developed for the moose and Northern long-eared bat because there were sufficient data to determine trends in the distribution and habitat use of these two species. It stated that the data used in habitat modeling was from the 2003 to 2004 field studies and from studies conducted in the TLSA.

According to Hammerstone, Habitat Suitability Index (HSI) modeling was used for the species for which field data was insufficient or where data analysis was unable to identify habitat preferences. It stated that the HSI models used measureable vegetation characteristics to predict the ability of a landscape to support a species. Ecosite phases defined in the vegetation assessment were used to determine habitat variability. According to Hammerstone, the HSI models generated a suitability value related to the suitability of habitat. The following HSI values were developed by the Applicant:

- Poor Quality (0.0 to 0.2) – limited food and cover and limited use as a corridor
- Marginal Quality (0.21 to 0.4) – habitat is of limited use, but will be of use for travel, resting and limited feeding
- Moderate Quality (0.41 to 0.6) – habitat will be used for feeding, cover and potentially breeding
- Good Quality (0.61 to 0.8) – preferred feeding area and cover, some breeding
- High Quality (0.81 to 1.0) – preferred habitat suitable for feeding, cover and breeding.

Hammerstone indicated that an analysis of habitat suitability and availability in the TLSA was conducted for each selected species for the baseline, peak Project development, and residual (reclamation) cases.

Hammerstone conducted a Least Cost Path (LCP) analysis to determine the relative cost of travel among habitat patches by assuming an animal would choose a path that provides security and presents the least level of effort in acquiring resources. According to the Applicant, the LCP analysis indicated that the Project was not expected to affect the movement and use of travel corridors by moose in the TRSA. It concluded that regional habitat losses associated with development of large projects in the region were more of a concern than disruption of connectivity among habitat patches in the Project area.

Hammerstone stated that effects of the Project on wildlife would not occur in isolation from the effects of other projects and human activity in the area. It assessed the effects of the Project development in the cumulative development scenario at a regional scale by examining moose habitat conditions expected over the life of the Project. The Applicant stated that it assessed regional, cumulative impacts of the Project on moose quantitatively because this species is of regional importance and there is ample field data available. Hammerstone indicated that the Project impact on other species in a regional context was assessed qualitatively.

Hammerstone concluded that the regional development of announced projects (in 2006) would cumulatively result in a nearly 40 percent reduction in good to high quality moose habitat and that the Project contribution to this reduction would be less than 1 percent. It was the Applicant's view that the creation of moderate or better moose habitat after Project reclamation would more than offset the effects on regional moose movement and habitat use. Hammerstone indicated that the Project would contribute to regional impacts on other species; however, due to the size of the Project it expected that the impacts would represent a very low contribution to regional, negative effects.

Hammerstone stated that at peak Project disturbance there would be a high (negative) impact rating for all of the species selected for detailed assessment as well as on songbird diversity. It predicted that habitat specialist species such as the fisher, amphibians, and interior forest birds would be affected by cumulative habitat loss and drainage changes associated with the Project. Once the site was reclaimed and converted to aquatic and upland conditions (i.e., residual effects), the Applicant predicted that the impact on the Canada lynx, great and boreal owls, fisher, northern long-eared bat and songbird diversity would continue to be high and negative, with moderate, negative impacts on the black bear.

The Applicant stated that the residual impact on moose and pileated woodpecker would be high and positive due to the creation of more littoral zones and (eventually) more mature forests in upland areas. It stated that an increase in littoral zones would also add to the available habitat for semi-aquatic species (e.g., waterfowl, shore birds and some mammals such as beaver and muskrat).

Hammerstone committed to the following wildlife management and mitigation actions to address wildlife impacts associated with the Project:

- Continue ongoing monitoring and maintenance of habitat enhancement structures (e.g., bat roost boxes, owl nest boxes, raptor nesting platforms) that were initiated in 2004 during development of the Muskeg Valley Quarry. It indicated that the use of these structures would be expanded if proven successful.

- Establish a minimum 200 m setback from the Muskeg River channel in order to not disturb the riparian and other habitats in this area. Hammerstone noted that a wetland in the vicinity of the Quarry of the Ancestors would also be protected because it was near the archaeological exclusion zone.
- Control access to the site and allow for controlled access through and around the Project for traditional resource users.
- Continue to participate in regional initiatives to develop management tools for resolving regional wildlife issues.
- Participate in regional wildlife monitoring programs.

3.7.1.2: Views of the Panel

The Panel concludes that the methodologies used by Hammerstone to determine the impact of the Project on wildlife are reasonable. The Panel acknowledges that the Project will have a high negative impact on all of the species selected by the Applicant for detailed assessment and on songbird species diversity. Even after the Project is reclaimed, the impact on the Canada lynx, great gray and boreal owls, fisher, northern long-eared bat, and songbird diversity is expected to continue to be high and negative.

The Panel accepts Hammerstone's contention that semi-aquatic species such as the Canadian toad will benefit from the creation of the shallow lake proposed in the EIA. The Panel also accepts that establishment of the shallow water lake will have a positive effect on moose populations which are a species of cultural and subsistence importance to the Community of Fort McKay. The Panel finds that animal use of the shallow lake will depend on accessibility; therefore, as a condition of approval, the Panel requires Hammerstone to design and construct the landform to allow for easy animal access to the quarry lake.

The Panel acknowledges that the establishment of a 200 m minimum setback from the Muskeg River to minimize habitat disruption is important for preserving this important riparian zone. Also, the Panel is pleased that the wetland complex in the northeast part of the property will be preserved since it falls within the Quarry of the Ancestors archaeological exclusion zone.

The Panel recommends that the wildlife management and mitigation programs established as part of the Muskeg Valley Quarry development be continued. This includes the maintenance of habitat enhancement structures installed around the Project site by the Applicant in 2004 that include owl nest boxes, raptor nesting platforms and bat roost boxes. The Panel notes that according to the Applicant, the usage of enhancement structures by wildlife in the Muskeg Valley Quarry area has been poor. For example, Hammerstone stated that there was no evidence the five owl nest boxes installed in 2004 were in use one year later. The Panel requires as a condition that

Hammerstone monitor the success of the habitat enhancement structures, increase their number if proven successful, and if found to be ineffective, look at other habitat enhancement measures.

The Panel is of the opinion that access management is important for reducing the effects of disturbances associated with the Project on wildlife. Access management measures recommended by the Panel include the reclamation of old and temporary roads in the Project area, the construction of manned and unmanned gates into sensitive habitat areas, and education of workers and contractors about the importance of access control. The Panel appreciates the importance of providing controlled access to the Community of Fort McKay to the Project area for traditional uses such as hunting and trapping.

The Panel acknowledges Hammerstone's commitment to monitor wildlife populations in the vicinity of the Project site in the next few years to better understand the response of wildlife to Project activities and disturbances. As a condition of approval, the Panel requires Hammerstone to coordinate the Project wildlife monitoring program with the reclamation plan update to be conducted every five years to gain a better understanding of the residual impacts of the Project on wildlife.

The Applicant is encouraged to participate in regional land use planning and environmental management initiatives. These initiatives are important for increasing baseline knowledge about wildlife habitat corridor widths, corridor usage, and habitat and connectivity in the Terrestrial Regional Study Area. The Panel appreciates the importance of standardized wildlife monitoring methods. Therefore, as a condition of approval, the Panel requires that the Applicant adopt standardized methods such as those that have been adopted in the Alberta Biodiversity Monitoring Program. The Panel notes that Hammerstone has an agreement with Syncrude Canada Ltd. and Husky Energy Inc. to share data on wildlife abundance, distribution and activity of wildlife in relatively undisturbed settings. The Panel recommends that Hammerstone continue this agreement since the information is beneficial in obtaining a better understanding of wildlife issues in the Terrestrial Regional Study Area.

The Panel is supportive of the commitments made in the July 29, 2008 agreement between Birch Mountain Resources Ltd. (now Hammerstone) and the Community of Fort McKay relating to wildlife. The commitments include consultation with the Community of Fort McKay on the development of the Project's wildlife monitoring and mitigation program, scheduling site clearing outside of the breeding and juvenile rearing seasons of important species, implementation of a no firearms, hunting and fishing policy for its employees and contractors, implementation of speed controls on the Project site to limit road kills, and enforcement of a food and food waste program to prevent the attraction of nuisance animals such as bears.

3.7.2: Fisheries and Aquatic Resources

3.7.2.1: Views of the Applicant

Hammerstone acknowledged that the potential effects of the Project on Fisheries and Aquatic Resources, at both local and regional scales of study, include:

- direct loss or alteration of fish habitat;
- fish mortalities from Project activities;
- blockages to fish passage (stream diversions, filling of quarry lake);
- changes to surface water quality (flow change, acidifying emissions, substance releases) affecting fish habitat/health; and,
- fish health/habitat effects related to the quarry lake (water quality, closure of surface water drainage).

Hammerstone indicated that the aquatic local study area (ALSA) included all the streams and waterbodies that might be directly impacted by the Project footprint or indirectly impacted through Project related activities. It noted that the ALSA included the lower Muskeg River, adjacent to the Project and the four unnamed streams that drain westward through the Project to the Muskeg River. Hammerstone said the aquatic regional study area (ARSA) included the Muskeg River watershed and mainstem of the Athabasca River, from the point of confluence with the Muskeg River, upstream to the mouth of the Firebag River.

Baseline Assessment
Hammerstone said that the EIA for fisheries and aquatic resources included a review of existing information. Hammerstone indicated that the Muskeg River had been extensively studied[9] in this regard in relation to oil sands developments within the watershed. In addition, Hammerstone indicated that, except for the Muskeg River adjacent to the Project, extensive field surveys to characterize the fish populations and habitat in the watercourses and water bodies within the ALSA had been conducted in the spring and fall of 2004 and 2005. It noted that habitat assessments and fish inventory methods were completed according to standard protocols developed for RAMP[10].

Hammerstone stated that, within the northeast drainage basin, the principal water course draining the ALSA and the Project site is an unnamed tributary to the Muskeg River. The Applicant said that the main stem of this tributary, designated as "unnamed stream 2", has two tributaries identified as "unnamed streams 3 and 4" in the EIA. Hammerstone noted that only the lower portions of unnamed streams 2 and 3 are within the footprint of the

---

[9] Examples: Alberta Oil Sands Environmental Research Program (1970), Regional Aquatic Monitoring Program, EIAs (Husky Energy Sunshine Thermal Project [2004], Shell Muskeg River [1997], Albian Sands Muskeg River Expansion [2005]

[10] Regional Aquatic Monitoring Program (Golder, 1998)

Project. Within the Muskeg River Direct Drainage Basin, Hammerstone identified an "unnamed stream 1" which forms an ephemeral drainage path between a small, shallow, non-fish bearing unnamed lake and the Muskeg River. In general, Hammerstone concluded that all the ALSA streams typically consist of sections of intermittent, non-definable channel interspersed with occasional open water wetland features (e.g., beaver ponds) and sections of well-defined channel.

Hammerstone indicated that three species of fish (Fathead Minnow, Brook Stickleback, Pearl Dace) were commonly captured in the lower reaches of unnamed streams 2 and 3. It determined that the all waterbodies comprising these stream complexes support spawning, rearing and potential over-wintering habitat. Hammerstone concluded that the fish habitat quality in the unnamed streams 2 and 3 was rated low to moderate for forage fish species with no potential to support sport fish species from the Muskeg River. Similarly, Hammerstone reported that unnamed stream 4, located within the north-east drainage basin and draining into unnamed stream 2 provides limited migration, rearing, spawning and potential over-wintering for forage fish species only.

Hammerstone assessed the fisheries and aquatic resources related to four reaches of the Muskeg River[11], extending 73 km upstream from the confluence of the Muskeg River with the Athabasca River. The Applicant stated that 24 species of fish have been recorded to utilize the Muskeg River. It concluded that the Muskeg River adjacent to the Project supports forage fish species, as well as, both resident and migrant fish species with sport and traditional use values (e.g., Arctic Graying, Burbot, Northern Pike, White Sucker, Longnose Sucker, Mountain Whitefish, Walleye, Bull Trout). In general, Hammerstone determined that the fish habitat within the section of the Muskeg River adjacent to the Project is diverse, largely because of the increased stream gradient that occurs as the river descends into the Athabasca River valley.

Application Case Assessment

Hammerstone stated that no direct loss or alteration of fish habitat would occur in the Muskeg River. To ensure the latter outcome, Hammerstone committed to maintain a 200 m setback between the Muskeg River and the Project boundary. The Applicant said adherence to this commitment would continue through the development of the Project to protect fish, fish habitat and riparian function along the Muskeg River. It also stated that the loss of any fish habitat that occurred as a result of constructed surface water diversions (e.g., quarry bypass channel) or through quarry development in unnamed streams 2, 3 and 4, would be compensated by constructed fish habitat developed offsite in an oxbow of the Muskeg River. Hammerstone indicated that the proposed fish habitat compensation plan would be compliant with the *Federal Fisheries Act* and DFO's 'No Net Loss' policy[12] for fish habitat. Hammerstone reported that the initial plan to compensate fish habitat loss by enhancing fish habitat in the quarry bypass channel was abandoned as a result of the closure drainage plan to be implemented for the Shell Muskeg River Mine Extraction Project on Lease 90.

---

[11] Waldner et al. 1980. Aquatic biophysical inventory of major tributaries in the AOSERP study area. Vol. ii, Atlas. A report prepared for the Alberta Oil Sands Environmental Research Program by LGL Ltd. AOSERP Project WS 3.4.

[12] Department of Fisheries and Oceans (DFO). 1986. Policy for the Management of Fish Habitat. Communications Directorate. Department of Fisheries and Oceans. Ottawa, Ontario.

Hammerstone acknowledged that fish passage and habitat connectivity between the Muskeg River and the unnamed streams east of the quarry would be moderately and negatively impacted over a long period of time. It said these impacts would be mitigated during the period of active quarry operations by the constructed quarry diversion channel. However, Hammerstone stated that, during infilling of the quarry lake, fish passage between the Muskeg River and the upper reaches of the south central and northeast watershed would be blocked until filling had been completed in an estimated 75 years. Hammerstone noted that connectivity between the Muskeg River and the small waterbodies in and upstream of the Project has been likely limited during recent years of below average surface water run-off.

Hammerstone concluded that Project related hydrological or groundwater effects would have no effect on fish populations or fish habitat in the lower Muskeg River or the smaller unnamed streams in the ALSA. The Applicant estimated that development and operations of the quarry would increase annual total discharge by 2.5 percent and increase mean annual runoff by 1 percent in the Muskeg River. It determined that water seepage rates from the Muskeg River into the quarry during peak operations would be 0.03 percent of the flow. The Applicant said that these hydrological effects to the Muskeg River were low in magnitude. Similarly, Hammerstone reported that the impacts of the Project on annual runoffs and peak discharges in the unnamed streams in the ALSA were low.

Hammerstone identified the following primary sources potentially responsible for changes in water quality related to fisheries and aquatic resources: sediment loading, discharge of treated quarry water, accidental spills and contaminant releases. The Applicant said that it was committed to the implementation of best management practices for erosion and sediment control to prevent total suspended solids (TSS) loading into streams in the ALSA. It stated that TSS monitoring would be conducted under water quality monitoring programs to ensure adherence to regulatory guidelines[13]. The Applicant indicated that excess water entering the quarry from precipitation and groundwater seepage would be collected, managed and released according to conditions in the Muskeg Valley Quarry approvals. Hammerstone acknowledged that containment of and response to accidental spills would be managed according to established procedures at the site.

Hammerstone stated that, upon quarry closure, a quarry lake, capable of supporting a self-sustaining fishery, would be created. It said the quarry lake would include fish habitat features (e.g., over-wintering areas, littoral zones, wetland areas) and connections to undisturbed channels upstream of the

---

[13] CCME. 2003. Canadian Water quality Guidelines for the Protection of Aquatic Life. Canadian Council of Ministers of the Environment

Project areas. The Applicant predicted that water quality in the quarry lake would be capable of supporting fish.

Cumulative Assessment

Hammerstone concluded that the predicted impacts of the Project to fisheries and aquatic resources within aquatic regional study area were negligible. It determined that the Project would not interact negatively with existing and proposed regional projects and, consequently, no cumulative effects related to fisheries and aquatic resources were expected.

3.7.2.2: Views of the Panel

The Panel accepts Hammerstone's baseline EIA findings and concludes that this information forms a reasonable reference base from which to evaluate future Project effects regarding the fisheries in the ALSA. The Panel finds the following baseline EIA results of relevance:

- Four complex waterways (unnamed streams 1-4) are found in the ALSA. These streams are characterized by intermittent flows, occasional open water wetlands and sections of a well-defined channel.
- All unnamed stream complexes support spawning, rearing and potential over-wintering habitat for forage fish.
- Fish habitat quality in the unnamed streams 2 and 3 is rated low to moderate for forage fish species, with no potential to support sport fish species from the Muskeg River.
- Sport and traditional use fisheries are found only in Muskeg River.

The Panel agrees with Hammerstone that the loss of fish passage and habitat connectivity between the Muskeg River and the unnamed streams located in the northeast and south-central drainage basins will be a negative and long-term Project impact on the ALSA fishery. However, the Panel also concurs with the Applicant that during the period of quarry operations, Hammerstone can satisfactorily mitigate these impacts to the ALSA fishery by constructing a quarry diversion channel, as proposed. The Panel expects Hammerstone to fulfil its commitment to construct the quarry diversion channel.

Hammerstone has acknowledged that a permanent loss of fish habitat in the unnamed streams found in the ALSA will result from Project related construction of surface water diversions and through quarry development. The Panel is aware that Hammerstone has committed to compensate any loss of fish habitat due to Project impacts by constructing fish habitat offsite in an oxbow of the Muskeg River. The Panel notes Hammerstone has committed to obtain a *Federal Fisheries Act* authorization in this regard. The Panel anticipates that this Authorization will include a compensation plan to mitigate project related HADD[14], as well as, any required conditions to address the long term loss of connectivity of ALSA tributaries to the Muskeg River. The Panel understands that the compensation plan will be compliant with the *Federal Fisheries Act* and consistent with the Department of Fisheries and Oceans' (DFO) 'No Net Loss' policy for fish habitat. The Panel understands that Hammerstone has committed to finalize discussions with DFO to fulfil the requirements of the amended *Federal Fisheries Act* authorization (AB-02-1299) prior to Project start-up.

---

[14] Federal Fisheries Act. Section 34. "fish habitat alteration, disruption or destruction" (HADD)

The Panel accepts Hammerstone's view that a setback between the Project boundary and the Muskeg River will buffer and minimize any Project related effects that may potentially impact fish populations or fish habitat in the lower Muskeg River. As a condition of approval, the Panel requires Hammerstone to establish and maintain throughout the period of quarry operations, a 200 m setback between the Muskeg River and the Project boundary to prevent any direct loss or alteration of fish habitat in the Muskeg River.

The Panel recognizes that surface water quality is an important factor in establishing a self-sustaining fishery. The Panel acknowledges that the Applicant has committed to implement best management practices for erosion and sediment control to prevent total suspended solids (TSS) loading into streams in the ALSA. The Panel is also aware that Hammerstone has committed to TSS monitoring as part of the surface water quality monitoring programs to ensure adherence to AENV regulatory requirements. The Panel expects Hammerstone to fulfil these commitments regarding TSS loading and monitoring in ALSA streams.

The Panel understands that the conceptual shallow quarry lake is anticipated to provide a self-sustaining aquatic ecosystem that will include a viable recreational fishery. In view of the unresolved issues related to the quarry lake concerning water quality, water quantity and available aquatic habitats, the Panel concludes that significant uncertainty remains as to whether the quarry lake will support a sustainable fishery as planned. As a condition of approval, the Panel requires Hammerstone to investigate and resolve the uncertainties that exist concerning a sustainable fishery and to present an appropriately revised quarry lake plan based on these findings. The results must be reported to Alberta Environment at the time of the reclamation plan review every five years.

SECTION 4: RECLAMATION

4.1: Views of the Applicant

Hammerstone acknowledged that the goal of reclamation is to restore the lands disturbed by limestone quarrying and processing, to an equivalent land capability[15]. It outlined procedures to be implemented in the Conceptual Conservation and Reclamation Plan (C&R) to achieve the latter goal. The Applicant anticipated that the land uses following reclamation would be substantially different from that which existed before disturbance. Hammerstone presented a C&R that includes two principal reclamation features:

- Constructed landforms: upland ridge areas created from a terrestrial base constructed by the managed placement and incorporation of spent lime, waste gypsum and quarried fill materials (un-saleable rock and geologic materials). The reclaimed upland ridge areas would provide a potential self-sustaining mixed-wood ecosystem, suitable for commercial forest production, wildlife habitats and recreational opportunities
- Quarry lake: functioning and sustainable aquatic ecosystem (littoral zones, shallow and deep water zones), providing aquatic habitats and new recreational opportunities

Hammerstone emphasized that the proposed, conservatively-based C&R was consistent with its corporate philosophy and the objectives of the stakeholders of this project.

4.1.1: Constructed Landform

4.1.1.1: Landform Rationale & Design

Hammerstone stated that the incorporation of waste solids from the flue-gas desulphurization (FGD) and fluidized-bed combustion (FBC) processes, spent lime from water treatment systems and quarried fill materials, into a designed landform within the reclamation program is in keeping with a full life cycle management philosophy adopted for its operations and the processed limestone products used by its regional clients. The Applicant said that a long-term, permanent facility(s) for the storage of waste solids generated from the use of lime or limestone in the mitigation of sulphur emissions from the combustion of alternate fuels (coke, bitumen, asphaltenes, coal) was required in the future for the region. It estimated that approximately 9.1×10^7 m^3 of spent lime and FGD/FBC waste solids would be generated by its customers over the course of the Project. Hammerstone submitted that the proposed constructed landform addresses this regional waste management need and facilitates the inclusion of a terrestrial component in the C&R.

Hammerstone said that, at this stage, the design of the constructed landform (size, shape, configuration, construction materials, proximity to quarry lake) was only conceptual in nature and open to optimization and to change depending upon the quantity and the characteristics of the materials regionally available to be incorporated into the landform. It reported that, as excavation of the quarry face progresses south, materials to be incorporated into the landform would be placed along the east side of the quarry. As a constructed buffer between the quarry lake and the latter, the Applicant planned to create a 300 m wide (minimum) zone with fill materials. Hammerstone stated that the design of a structure to hold the spent lime and FGD/FBC waste solids, could feature a cell built above the water table with full encapsulation (1 m thick compacted high shale liner), a cell with a leachate collection system and a 300 m setback from the quarry lake or a cell with no capping, lining , leachate collection or setback. Hammerstone estimated the lifetime of the Project to be 42 years and anticipated that the landform construction would begin within 15 years from the start of quarrying. It reported that the final conceptual dimension of the constructed landform would be 6100 m (length) x 845 m (width), with a total constructed upland surface area of 2.7×10^4 ha and slopes of 9:1 to 10:1. Hammerstone stated that it was committed to prepare, prior to facility construction, a "Gypsum Landform Design Plan and Specifications", based on actual characterization data and site specific groundwater and geochemical modeling using regional FDG and FBC material samples.

---

[15] Alberta Regulations 115/93, 1993

4.1.1.2: Landform Materials

The Applicant reported that the landform cells (liner, cap) would be constructed from fill material (fine shale reject; fines from screening, crushing, washing, dust filter operations) and geologic material from Unit 3 which is high in shale content. Based on the results of tests on samples of shaley reject material from aggregate processing and unprocessed rock from Unit 3, Hammerstone concluded that the permeability of these materials was low, with a hydraulic conductivity in the order of 1×10^{-11} m/s.

Hammerstone stated that off-site FGD/FBC waste solids would be accepted for return to the quarry as part of the reclamation program. The Applicant anticipated the receipt of a wide range of solids, sludges and liquids at a designated facility designed to accept, store and potentially process (e.g., dewatering) the latter materials.

The Applicant summarized the physical, chemical and leachate characteristics of FGD/FBC solid materials, employing published information[16]. However, Hammerstone acknowledged that most of the data presented originate from the coal-fired power industry and that directly comparable information for fuels likely to be burned in the oil sands area (natural gas, petroleum coke, asphaltenes) is lacking. Hammerstone noted that the characteristics of FGD/FBC solids are dependent on a number of factors: composition of lime/limestone, composition of fuel being burned, operating conditions of burner, recycling/reactivation of desulphurization material, amount of fly ash incorporation (stabilization/fixation), dewatering or other treatments. Based on the literature, Hammerstone stated that the major constituents of FGD/FBC materials were: gypsum ($CaSO_4[H_2O]_2$), anhydride ($CaSO_4$), calcium sulphite ($CaSO_3$), calcium carbonate ($CaCO_3$), lime (CaO), aluminosilicates and trace elements (e.g., Ba, Ni, V, Zn). It reported that, if fuel oil was not used for combustion, organic constituents of concern such as polycyclic aromatic hydrocarbons (PAH) and dioxins in FGD/FBC materials and leachates were at or below detection limits. The Applicant indicated that FGD/FBC materials are relatively high in pH, resulting in the leaching of anionic chemical species (arsenic, selenium, sulphate). Hammerstone stated that it is committed to fully characterizing all FGD/FBC materials to be placed in the landform, to conduct the necessary groundwater and geochemical modeling to assess potential ecological and human health risks and to mitigate any potential adverse effects through engineering design and operations planning.

---

[16] USEPA. 1999. Wastes from the Combustion of Fossil Fuels; Energy & Power Research Institute. 2003. Information in the Proceedings of the 17th International Fluidized Bed Combustion Conference.

Under current legislation in Alberta, the Applicant said that two possible options exist for approving the use of FGD/FBC materials for reclamation; namely, regulating the placement of these materials in the landform as *release of a substance* under EPEA[17] or regulating these materials as *inert waste*[18] used for reclamation. Hammerstone stated that, in its opinion, FGD/FBC materials that are to be placed within the landform could be classified as inert waste. Hammerstone defined *inert waste* as solid waste that, when disposed in a landfill or not re-used, is not reasonably expected to undergo physical, chemical, or biological changes to such an extent as to produce substances that may cause adverse effect. The Applicant indicated that this definition of *inert waste* has been accepted by the regulator and applied to FGD materials currently being used as a stabilizing agent in the oil sands mine reclamation programs (e.g., consolidated tailings, composite tailings). Based on the results of an adapted Toxicity Characteristic Leaching Protocol (TCLP) test conducted on a synthetic FGD sample[19], Hammerstone concluded that these materials were unlikely to cause an adverse effect as the predicted concentrations of Mg, Ag, Tl and V in the leachate could exceed drinking water guidelines but not Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life.

From a review of the published leachate data on FGD/FBC waste materials, Hammerstone reported that only the maximum level of Se in FGD solids exceeded the CWQG. The Applicant stated that groundwater in the Hammerstone area is of poor quality, exceeding CWQG and Groundwater Performance Standards[20] concentrations in arsenic, total iron, total manganese, sodium, chloride and total dissolved solids. Hammerstone maintained that the landform constructed from FGD/FBC materials should not be considered a landfill, requiring approvals beyond the EPEA approval for the Project. Regardless, Hammerstone concluded that the physical properties of the underlying Christina, Calument and Firebag geologic members were consistent with the characteristics and performance criteria required by Alberta Environment (AENV) for Class II landfills in Alberta[21] (e.g., absence of fractured non-porous bedrock or karst features).

---

[17] AENV. 2007. Draft Standards for Landfills in Alberta

[18] EPEA. 1996. Waste Control Regulations (Alberta Regulations 192/1996)

[19] Syncrude Canada Ltd. 2003. Application to Amend for the Mildred Lake Plant Emissions Reduction Project

[20] See footnote 17

[21] AENV. 2004. Standards for Landfills in Alberta

The Applicant stated that, over the course of the next few years, spent lime (mixture of hydrated $CaCO_3$, $Mg[OH]_2$, $MgCO_3$) generated in Northern Alberta would be sampled and analyzed (e.g., trace metals, organics) to assess the characteristics of spent lime in the region. Hammerstone said that, during the course of operations, off-site spent lime accepted onto the site would be sampled and analyzed for suitability of potential use in operations (re-calcining) or reclamation.

4.1.1.3: Risk review

Hammerstone stated that a risk review, related to the conceptual plan featuring a constructed landform, had been completed. It identified the following hazards associated with the use of waste FGD/FBC solids and spent lime in the constructed landform:

- FGD/FBC solids and spent lime constituents leaching into surface water and groundwater;
- particulate matter arising from landform; and,
- hydrogen sulphide off-gassing under certain conditions (anaerobic, presence of sulphate reducing microorganisms, organics).

The Applicant said that the following mitigation measures were planned to address and eliminate risk related to the landform:

- containment of FGD/FBC solids and lime waste by enclosure in a cell lined with 1 m of compacted high shale content geologic material to prevent leachate migration;
- capping of containment cell with 1 m of compacted high shale content geologic material to prevent infiltration of precipitation and to prevent upward leaching and release of any H_2S off-gas;
- covering of ridge portion of landform with 3 m of overburden and reclamation soils to serve as a physical barrier to the containment cell and contents;
- placing FGD/FBC solid and waste lime into cells as wet materials to enhance the consolidation of the latter into a solid matrix and minimize free particulates;
- controlling landform runoff and release to environment during operations;
- designing landform drainage to minimize seepage into landform;
- segregating FGD/FBC solids and spent lime; and,
- minimizing conditions that are optimal for H_2S generation (e.g., saturation with water, presence of labile organic matter, presence of sulphates).

4.1.2: Quarry Lake

Hammerstone emphasized that the planned quarry lake and associated wetland/littoral features were integral to the conceptual C&R outcome. Based on an understanding of the quality and quantity of surface water and groundwater in the aquatic local study area, the Applicant stated that a viable quarry lake could be created. Hammerstone emphasized that the quarry lake and aquatic features would be an ecologically sustainable, functional aquatic ecosystem (biologically viable, diverse aquatic habitat). As the quarry lake and wetlands would be connected to the Muskeg River, a sport fish bearing stream, Hammerstone said the quarry lake would be constructed in a manner that would support fish. The Applicant indicated that, as the Project concluded, a design that enhanced desired aquatic and wetland end-uses would be finalized.

4.1.2.1: Quarry Lake Design

In the Project Application submitted May 24, 2006, Hammerstone said a substantial portion of the quarry pit that existed at the end of the Project, would become a quarry lake. To support fish growth and survival, the Applicant conceptualized a quarry lake with varying depths (over-wintering areas >2.0 m, littoral/wetland areas 0.5 – 2.0 m) and reduced shore slopes (3:1). Hammerstone planned 4 constructed littoral/marshland zones along the shores of the quarry lake that accounted for approximately 27 percent of the total quarry lake surface area of 685 ha. It indicated that the quarry lake and littoral/marshland features would be constructed from excess fill materials, with the latter areas receiving a surface cover of topsoil (30 cm) to promote vegetative growth. Hammerstone expected filling of the original quarry lake to begin when the quarrying ended and the filling of the lake from precipitation, surface water and groundwater inflows to take 54 years, resulting in an average lake depth of 44 m.

The Applicant stated that regulatory approval of the closure drainage plan for the Shell Muskeg River Mine Extraction Project on Lease 90 (Nov. 2007), would result in a significant diversion of surface water away from the Muskeg Valley Quarry and Hammerstone Quarry. In re-evaluating the water balance for the quarry lake, Hammerstone concluded that the time required to fill the quarry lake would now be 162 years, constituting an unacceptable scenario. Hammerstone evaluated seven potential options to resolve the issue:

- stay the course and accept that filling of quarry lake would take 162 years;
- re-establish Lease 90 closure drainage flows toward Hammerstone to support quarry lake filling as originally proposed;
- fill pit with overburden from nearby oil sands project(s) and reclaim to a terrestrial upland;
- fill most of quarry with overburden from nearby oil sand(s) projects and reclaim as constructed wetland;
- use Athabasca River water to quickly fill quarry lake;

- use Muskeg River, on a seasonal basis (e.g., spring freshet) to fill quarry lake; or,
- construct a shallow quarry lake by filling the base of quarry pit with overburden from nearby oil sands project(s) and topping with water.

Based on regulatory, EIA and technical considerations, Hammerstone concluded that the shallow quarry lake option was the most acceptable solution. Assuming an average shallow quarry lake depth of 3 m, a porosity of 30 percent for the overburden infill of the quarry pit and a water fill rate of 980,000 m^3/yr, Hammerstone estimated that the quarry lake would fill in 75 years.

4.1.2.2: Quarry Lake Water Quality

Hammerstone said that an evaluation of the physical and chemical characteristics of water quality in the proposed quarry lake would be possible once the size and shape of the lake becomes better known. Hammerstone expected groundwater inflow, estimated at 3.7×10^6 m^3/yr, to be a major driver of water quality in the quarry lake. It reported that the total dissolved solids (TDS) concentration of the groundwater was 6510 mg/l. Hammerstone stated that elevated concentrations of some elements would occur in the lake water at first (e.g., total Fe, Cu), reflecting the characteristics of the groundwater inflow. The Applicant anticipated the water quality of the quarry lake to continuously improve as surface water inputs gradually replace that of groundwater. However, Hammerstone acknowledged that until the lake design has progressed sufficiently, the inputs to the lake from the landform component were only estimated and, until the water systems that would fill and supply the lake were better defined, it was not possible to evaluate water quality in any detail.

In evaluating the potential chemistry of the proposed quarry lake, Hammerstone committed to assess the potential concentration of anionic metalloids (e.g., As, Se) and sulphate due to leaching in alkaline water bodies (pH 7.5-8.5) such as mine pit lakes. It said that the latter would be addressed by analyzing water within the quarry and conducting leachate studies of different bedrock materials and geochemical modeling. Hammerstone stated that the quarry lake is projected to be significantly different in many ways from an end pit lake developed within an oil sands mining project.

Hammerstone maintained that complete mixing of the quarry lake water was a conservative approach to evaluating lake water quality and potential biological outcomes. Hammerstone reasoned that mixing would result in higher solute concentrations in the upper layer of a stratified lake, where the majority biological component of the lake would occur. The Applicant concluded that stratification and isolation of solutes in the lower layers of the lake would mean better water quality in the upper lake water layer.

4.1.3: Conservation of Soil Resources for Reclamation

Hammerstone acknowledged that the salvaged soil resources were valuable for final reclamation and were to be stored in a manner that would minimize loss and degradation until required. Hammerstone identified the reclamation soil resources were:

- Topsoil (L,F,H horizon[22]; 15 cm mineral soil ; 25 percent [volume/volume] organic soils), salvaged when grading or excavating, and
- Subsoil salvaged from quarrying operations.

Based on the inventory of soil resources conducted in the EIA, Hammerstone explained that estimated topsoil and subsoil thicknesses for each soil series in the local terrestrial study area were used to calculate the volumes of reclamation materials available. It stated that the segregated stockpiles of salvaged reclamation soils would be contoured and revegetated to minimize wind and water erosion. The Applicant said that mineral and organic soils mixing would be conducted to improve the organic matter content of soils used for final reclamation.

Hammerstone anticipated that all the salvaged subsoil would be utilized for reclamation. However, it said that unused salvage topsoil is to be contoured, revegetated and left in place.

4.2: Views of the Panel

The Panel appreciates that the C&R presented by Hammerstone is conceptual in nature. The Panel also accepts that Hammerstone requires some flexibility in the design and operational details outlined in the Plan, considering the timelines involved to implement and complete the C&R, the potential future advances in the technology and science of oil sands reclamation, the nature and impact of future regional project developments and the possibility of future regulatory change. However, the Panel expects the proposed Plan to accurately reflect current regulatory expectations and requirements and the Applicant to provide reasonable assurance that the Plan will be feasible and successful in achieving the reclamation objectives proposed. In this regard, the Panel has considered the uniqueness of the principle elements of the reclamation plan proposed and finds a number of significant uncertainties which are of concern:

- Availability of FGD/FBC and spent lime materials in the region, considering: (1) increasing competing use of these materials for oil sands process tailings stabilization, (2) economics of materials transportation and selection;
- Acceptability of regional FGD/FBC materials and spent lime to be incorporated into landform, considering: (1) physicochemical characterization of these materials is lacking, (2) "materials selection criteria" has not been established;
- Nature and extent of regulatory and company resources required to manage and ensure that only "acceptable" wastes are incorporated;

---

[22] Organic horizons developed primarily from the accumulation of leaves, twigs, and woody materials with or without a minor component of mosses. L,F,H horizons are normally associated with upland forested soils with imperfect drainage or drier. Canadian System of Soil Classification, 3rd edition. 1998. Natural Resources Canada. Ottawa, Ontario.

- Hydrogeologic suitability of the Hammerstone site for a repository of this nature and size. Assessment data to fully support the view that this site will meet AENV Class II landfill siting requirements is lacking;
- Long-term geotechnical stability and integrity of constructed upland landform. There are no comparable engineered landforms of this nature and size currently in Alberta;
- Magnitude, chemical characteristics and impacts of leachate potentially generated from upland landform; and,
- Feasibility and long-term viability of the quarry lake as a sustainable, functioning aquatic ecosystem.

While acknowledging that Hammerstone may not be able to resolve all of these uncertainties completely at this time, the Panel concludes that insufficient information has been provided to reasonably determine whether or not the C&R will successfully achieve the stated reclamation objectives. The Panel also finds that the C&R offers no potential options, should a principal element of the proposed Plan prove to be unfeasible. In order to address this issue, the Panel holds Hammerstone to its stated commitment and requires the Applicant, as a condition of approval, to prepare and submit to AENV for review and acceptance prior to construction of the landform, a document entitled "*Gypsum Landform Design Plan and Specifications*." The Panel requires this plan to be based upon actual site evaluation data and the results of site-specific groundwater and geochemical modeling, using the characterization data from a statistically relevant number of samples of FGD/FBC and spent lime waste materials from various regional sources.

The Panel is aware that the FGD/FBC and lime wastes to be incorporated into the constructed landform are subject to established redox and solution dependent chemical and biological transformations which may cause an adverse effect. On this basis, the Panel is not convinced that the latter materials, if handled and stored as proposed, are *inert wastes* as defined in *EPEA* (*Waste Control Regulations: Alberta Regulations 192/1996*) and recommends that AENV address this issue carefully. While acknowledging that the final decision regarding regulation of the landform rests with AENV, the Panel is of the opinion that the fundamental performance standards for a Class II landfill as outlined by Alberta Environment[23] could apply to the construction, operation, management and monitoring of the landform. Should AENV concur with the Panel conclusion on this issue, the Panel recommends that AENV consider the following sections of the Class II landfill standards which the Panel finds particularly but not exclusively, relevant to the proposed landform:

- Section 2: Landfill Development and Siting
- Section 3: Design and Construction
- Section 4: Landfill Operations (subsections: 4.3, 4.4, 4.8, 4.10)
- Section 5: Monitoring, Analysis and Corrective Action
- Section 6: Final Landfill Closure and Post-Closure (subsection 6.2, 6.3)
- Section 7: Record Keeping and Reporting (subsection: 7.1, 7.3, 7.5, 7.6)

---

[23] Government of Alberta. Alberta Environment. 2010. Standards for Landfills in Alberta. http://environment.gov.ab.ca/info/library/7316.pdf

In view of the uniqueness of the proposed reclamation landform, the Panel understands that the final regulatory details to be implemented regarding the landform will require consultation by the Applicant with AENV. The Panel is confident that AENV's Director of Approvals, Northern Region will adequately address the regulatory issues related to the potential environmental impact concerns associated with the proposed landform.

The Panel notes that Hammerstone, in constructing the upland landform, has committed to place 30 cm of topsoil over the subsoil cover (3 m) and the cap (1 m) of high shale content fill material used to close the cell containing waste gypsum and spent lime. In considering the stated reclamation objective for the constructed upland landscape (self-sustaining mixed wood ecosystem) and the relevant regulatory guidelines[24], the Panel finds Hammerstone's proposed thickness of topsoil replacement to be minimal with little demonstrated evidence of sustained success. Hammerstone has reported that an excess of stored topsoil materials will result upon completion of the proposed C&R. Consequently, the Panel concludes that a reclamation strategy that is precautionary and one that has been adopted in recent oil sands mine approvals is appropriate. The Panel notes Hammerstone's commitment to the Fort McKay First Nations[25] to employ a minimum surface placement of 50 cm of topsoil cover for the reclamation of upland ecosites. Therefore, as a condition of approval, the Panel requires Hammerstone to employ a minimum 50 cm topsoil cover for the surface reclamation of constructed upland landscapes.

The Panel notes that Hammerstone, as a requirement of its *EPEA* approval for the Muskeg Valley Quarry operation, will submit an updated reclamation plan to AENV no later than 5 years from the approval date of issuance, unless otherwise authorized in writing by AENV. As a condition of approval, the Panel requires that Hammerstone update the reclamation plan for the Project every 5 years and submit this to AENV. Further, as a condition of this approval, the Panel requires that the ongoing, updated C&R include for implementation, any relevant outcomes that have been developed through consultation with affected stakeholders and any significant advances in the technology and knowledge of land reclamation in the region.

The Panel understands that reclamation security is routinely required under *EPEA* and the *Conservation and Reclamation Regulation*. The Panel, therefore, understands that a security deposit will be a requirement of AENV's approval for Hammerstone's C&R. The Panel recommends that the nature, magnitude and conditions of the security deposit established are meaningful and in keeping with the uniqueness of the terrestrial and aquatic reclamation elements proposed and the uncertainties associated with the outcomes of the conceptual Plan.

---

[24] Oil Sands Vegetation Reclamation Committee. 1998. Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region.

[25] Bilateral Cooperation Agreement Between Birch Mountain Resources and Community of Fort McKay. 2008.

SECTION 5: LAND AND RESOURCE USE

5.1: Views of the Applicant

Hammerstone indicated that the Project would be developed in an area that has many non-traditional land and resource uses, including Crown land surface activity, dispositions and reservations, and notations for mineral, oil and gas resources, granular resources, public use or protection and forestry, environmentally significant areas (ESA), special places and historic sites, and consumptive and non-consumptive outdoor recreational pursuits. Hammerstone assessed the potential overlapping and competing non-traditional land use interests within the Terrestrial Local Study Area (TLSA), and used the Terrestrial Regional Study Area (TRSA) in assessing the potential regional cumulative effects.

In conducting its assessment, Hammerstone reviewed existing land and resource use information, contacted local knowledgeable individuals, recreational clubs and associations, and conducted field surveys. It identified the following special permit stakeholders with interest in the land within the TLSA:

- Shell Canada Ltd. holds a Consultative Notation for Companies and wanted to be consulted before any commitment or disposition is placed on the land;
- The Alberta Department of Energy and Alberta Energy and Utility Board hold Consultative Notations for future limestone development, future placer gold development and future industrial/commercial site and requested to be consulted before any commitment or disposition is placed on the land;
- Alberta Environment and Public Lands hold disposition reservations for a meteorological and hydrometeorological monitoring site and for trails, and require their consent prior to the Project development;
- Aboriginal Affairs and Northern Development has a Holding Reservation pertaining to Fort McKay Treaty Land Entitlement Claim;
- The Public Lands and Forests Division holds a Protective Notation, placing a restriction on the land for the Saline Lake Recreation Trail Buffer; however this was set to expire on December 31, 2006;
- Fort McKay General Contracting Ltd. holds a Surface Material Lease and a Conservation and Reclamation Plan for sand and gravel resource extraction;
- Atco Electric Ltd, Syncrude Canada Ltd., and Albian Sands Energy Inc. hold power line easements;
- Husky Oil Operations Ltd., Albian Sands Energy Ltd. and Atco Pipelines hold pipeline agreements;
- Hammerstone, Shell Canada Ltd. and Syncrude Canada Ltd. hold Licenses of Occupation that grant the holder the right to access roads and other industrial development;
- Hammerstone and Albian Sands Energy Inc. hold Miscellaneous Leases for quarries; and,
- Stony Valley Contracting Ltd. holds a Surface Material Exploration permit for exploring sand and gravel.

Hammerstone stated that it had followed an open consultation strategy with the above stakeholders and committed to continue to consult with them in order to avoid potential conflict prior to commencing project development. Hammerstone concluded that there would be no adverse effects in regard to land use activities or interests with the above listed stakeholders if open communication continues.

The Applicant stated that the TLSA rested within both the Alberta-Pacific Forest Industries (Al-Pac) Forest Management Agreement and Northland Products Coniferous Timber Licence and the Project might affect adversely their interests in two ways. Firstly, the timber clearing for the Project might interfere with Al-Pac's and Northland Product's cut plans, unless timber clearing in the Project area was included in their Annual Allowable Cut. To mitigate this potential impact on tree clearing, Hammerstone stated that it would pay Al-Pac for the trees and pay the Alberta government for timber damage. In addition, Hammerstone would harvest the trees according to a management plan and provide them to Al-Pac or Northland. Secondly, Hammerstone acknowledged that the Project would cause a permanent loss of harvestable land base since a portion of the quarry pit would be reclaimed into a quarry lake. Hammerstone stated that the Project would clear 32.7 percent (8,262 m^3) of the merchantable timber volume in the TLSA. This area corresponded to 0.01 percent of 65,522,000 m^3 in the A15 forest management unit (FMU), which represented a negligible loss of harvestable land base for forestry operators in the FMU. Hammerstone concluded that the Project would cause no adverse effects to forest resources or to the harvestable landbase for the forestry sector.

Within the TLSA, Hammerstone found an ESA, the Muskeg River, which had been identified as a regional significant sport fishery. Hammerstone stated that it would preserve 200 m buffer between the Muskeg River and the Project, which exceeded the 100 m buffer required by Alberta Sustainable Resource Development. Hammerstone concluded that there would be no adverse affects on the Muskeg River ESA during or following Hammerstone operations.

According to Hammerstone, the Historical Resources Impact Assessment and EIA identified significant archaeological sites in the northeast corner of the TLSA. The Applicant stated that it would exclude this area from its development plan and recommended to Alberta Community Development (ACD, now Alberta Culture and Community Spirit) to preserve this site as an archaeological reserve. Subsequently, ACD named the area as "Quarry of the Ancestors." Hammerstone concluded that the area would be protected and therefore no adverse effects were predicted.

Hammerstone indicated that hunting in the northern part of the TLSA was now prohibited. The Applicant acknowledged that as the Project extends south, hunting access within TLSA would be reduced. The Applicant calculated that wildlife management unit (WMU) 530 would be reduced by 0.06 percent by the Project, which represents 1,265 ha. Thus, Hammerstone concluded that the reduction of hunting area would have no adverse effects on hunting opportunities.

Hammerstone recognized that the opportunity for non-consumptive recreation activities, such as hiking, walking, quadding, and trail biking would decrease in the TLSA because access to the Hammerstone area would be restricted. It indicated that on the other hand, the Project would not affect the area of the TLSA located to the north of the Muskeg Valley Quarry (MVQ). According to Hammerstone, the Project would develop southward from

MVQ, where it is mostly muskeg. The Applicant predicted that this area would be undesirable for outdoor activities because it would be difficult to access during the summer. It concluded that adverse impacts to non-consumptive recreation activities would be negligible. Further, Hammerstone speculated that water sport opportunities might increase when the quarry was reclaimed to a lake.

Hammerstone stated that with the formation of the quarry lake as a mitigation measure, there would be negligible adverse effect on non-traditional land and resource use during the life of the Project. Therefore, the Applicant concluded that no cumulative effects assessment was necessary for the non-traditional land and resource use component.

However, Hammerstone expected cumulative land use disturbance in the TRSA to be high and long term, if all existing or approved future projects proceeded to develop and expand to their maximum proposed development areas. Hammerstone indicated that it would seek full membership with the Cumulative Effects Management Association, Regional Issues Working Group and Wood Buffalo Environmental Association in 2010 and continue to support the resolution of regional issues through participation, and would address issues relating to regional development and associated cumulative effects.

5.2: Views of the Panel

The Panel acknowledges the complexity in the number of legal interests in the Project area. However, as none of the identified parties came forward with a Statement of Concern, the Panel concludes that the Applicant stakeholder consultation efforts have been successful. The Panel encourages Hammerstone to continue the open communication and consultation with interest holders.

The Panel recognizes that there are many changes in access to recreation in the Project area. The Panel observes that the viability of the proposed quarry lake to provide recreational use is uncertain due to the quantity and quality of surface water in the quarry lake. The Panel encourages Hammerstone to commit its membership to regional groups that will address recreational opportunities in the region.

The Panel expresses its support for provincially mandated regional planning processes currently underway that will address many issues including land and resource use.

SECTION 6: TRADITIONAL RESOURCE USE AND ECOLOGICAL KNOWLEDGE

6.1: Views of the Applicant

Hammerstone conducted an assessment of the potential impacts of the Project on traditional activities of the Fort McKay First Nation (FMFN) and the Athabasca Chipewyan First Nation (ACFN); it indicated that this assessment was subjective in nature. In addition, the Applicant had consulted with the Fort McMurray Métis Nation of Alberta Local 1935 (ML 1935). Hammerstone indicated that the Mikisew Cree First Nation (MCFN) had not submitted its Traditional Land Use study for Hammerstone to assess.

Within its assessment, the Applicant considered that the environmental components of wildlife, plants, water, land, social/cultural, air and noise are of value and significance to Aboriginal communities.

In conducting its traditional resource use and ecological knowledge assessment, the Applicant used the same local study area of the Environmental Impact Assessment as that used for the soils, vegetation and wildlife, as the Applicant recognized terrestrial resources are critical components of traditional lifestyles. It had also distinguished two periods of traditional land use: historical (pre-1967) and current (post-1967). Hammerstone observed that the FMFN has intense culturally significant resource use within the whole of the terrestrial local study area of the Project.

Hammerstone reviewed existing information (regional studies), conducted consultation activities and field surveys to collect information on the following for its traditional resource use and ecological knowledge assessment:

- trapping, hunting, fishing;
- traditional plant harvesting;
- vegetation and wildlife used for nutritional and medicinal purposes;
- sites of traditional importance such as cabins and campsites, burial sites, cultural/spiritual sites and mineral licks; and,
- historical and current trails.

Hammerstone indicated that access to the Project area would be controlled for safety reasons. The Applicant indicated it had an access management plan that outlined how it would facilitate access to undeveloped portions of the Project area for traditional use.

The Applicant concluded that the Project would have the following impacts on traditional activities of the First Nations in the Project area:

- a moderate negative impact on cabin sites and other significant areas of the FMFN, with no impact on the ACFN. No burial sites were identified by the FMFN within the Project area;

- a high negative impact on traditional plant harvesting of the FMFN (1,245 ha of traditional plant harvesting area would be affected by Project activities), with a low negative impact for the ACFN;
- a high negative impact on hunting of the FMFN, with a low negative impact for the ACFN;
- a low negative impact on fishing due to maintaining a 200 m setback from the Muskeg River; and,
- a moderate negative impact on trapping of the FMFN due to a 3.1 percent overlap of two traplines within the Project area, with no impact on the ACFN.

Hammerstone acknowledged that losses in trapping opportunities associated with traplines 2006 and 2718 have the potential to considerably compromise opportunities to communicate traditional knowledge from the older generation to the younger.

Hammerstone indicated that the effects from operating, approved and proposed regional developments would cumulatively impact approximately 139,168 ha (13.2 percent) of the total area that was available to members of the FMFN for trapping activities. The Hammerstone Project represents 0.9 percent of the total cumulative disturbance. Hammerstone stated that cumulative impacts to traditional land use and traditional ecological knowledge were high.

The Applicant indicated that it would mitigate the negative impacts of the Project on traditional activities by:

- using plant species of traditional value during reclamation;
- maintaining the 200 m riparian buffer adjacent to the Muskeg River;
- protecting habitat around the Quarry of the Ancestors;
- minimizing disruptions to trapline permit holder's access through an Access Management Plan;
- providing trapline permit holders compensation for direct loss of trapping opportunities;
- considering flexible employment opportunities to allow participation in the non-traditional economy; and,
- providing opportunities for local Aboriginal employment.

In May 2008, the Applicant stated that it had reached a Bi-lateral Cooperation Agreement with the Community of Fort McKay, as represented by Fort McKay Industry Relations Corporation (IRC). In the Agreement, Hammerstone stated that it would work cooperatively with IRC to address environmental, social and economic objectives.

In a May 2010 letter to the NRCB, Hammerstone stated that it had signed a "Good Spirit Relationship" agreement with the ML 1935 in February 2010. According to the Applicant, the agreement outlined the framework for consultation and mutual understanding of Hammerstone's operation and its relation to the ML 1935. In addition, Hammerstone stated that it had entered into a Memorandum of Understanding with MCFN in October 2009 that represented the framework for working towards a bilateral agreement.

Further, the Applicant acknowledged in its May 2010 letter to the NRCB that it did not have an agreement in place with the ACFN. Hammerstone indicated that there were numerous meetings with the ACFN over the past two months and believed that it would reach an agreement with the ACFN in the near future.

6.2: Views of the Panel

The Panel finds that the FMFN are the closest residents and most directly affected by the Hammerstone development due to their traditional use of the Project area. The Panel notes that the FMFN did not submit a formal objection to the NRCB regarding the Hammerstone application and further, that Hammerstone has reached a comprehensive Bi-lateral Cooperation Agreement with the Community of Fort McKay. The Panel is supportive of these types of agreements and concludes that through this agreement Hammerstone and FMFN have established a satisfactory approach to addressing any concerns.

In addition, the Panel encourages the Applicant to continue its efforts to enter into formal cooperation agreements with other aboriginal groups in the vicinity of the Project area and to continue with its efforts to promote open communication, consultation and cooperation with other Aboriginal peoples in the area and stakeholders that may be impacted by the Hammerstone Project.

SECTION 7: SOCIO-ECONOMIC ISSUES

7.1: Views of the Applicant

The Applicant contended that the Project would provide a variety of benefits to the Regional Municipality of Wood Buffalo (RMWB) and the province. It indicated that the Project would provide jobs to local residents and provide opportunities for local businesses to supply products and services. In addition, Hammerstone indicated that the Project would provide a local supply of building materials for oil sands developments, and provide a local capability to manage spent lime and flue gas desulphurization solids from oil sands plants.

In the opinion of Hammerstone the RMWB is the spatial area of greatest interest for the purpose of a baseline analysis. The RMWB is the economic region surrounding the Hammerstone Project (the "Project") and the Applicant expected that most of the human and other resources for the construction and operation of the Project would be drawn from the region.

In the 2006 EIA report, Hammerstone estimated that the Project construction cost would be about $674 million (2006 dollars). Construction was initially proposed to start in 2006 and was targeted for completion in 2040. Hammerstone modified the processing plant design in 2007 and the resulting construction cost was revised to $578 million.

In a letter to the NRCB dated October 26, 2009, Hammerstone indicated that no changes were contemplated for the quarry plan contained in the EIA and that limestone production estimates had not changed. However, the Applicant modified the construction schedule to reflect a two year delay in Project approval. Hammerstone indicated that current cost estimates were used in 2009 to amend the Project construction cost to $739 million.

The Applicant indicated that the construction activity would be seasonal, shutting down for the winter months and peaking during the summer. According to Hammerstone, the direct employment in the RMWB region as a result of Project construction would amount to 385 person-years. Hammerstone concluded that since the regional workforce was currently fully employed, all construction-related work could be considered new employment in the RMWB, but would be insignificant relative to planned oil sands development construction over the same time period. Using 2006 information from Alberta Economic Development, the Applicant noted that within the region there were 64 major projects proposed, pending or underway worth about $63 billion.

Hammerstone stated that to quarry the current level of 7 million tonnes/year of limestone from the existing Muskeg Valley Quarry (MVQ), a workforce of 50 people would be required. The Applicant stated that Plant operations would commence in 2009 and would gradually expand as additional components were brought on line. In 2020 the Project would require a workforce of 343 people in addition to the 50 people employed at MVQ. To facilitate 24-hour plant operations, the Applicant indicated that most of the people would work 12-hour shifts, days and nights, eight days on and four days off. According to Hammerstone the annual operating costs in 2020 would be $111 million, of which $75 million would be spent in the RMWB and the balance elsewhere in Alberta.

The Applicant stated that by 2020 the workforce would require a much more diversified skill set than the present MVQ with the addition of professional staff, administrators and maintenance contractors in addition to the increased number of equipment operators.

Hammerstone stated that the annual costs of operating the Project would increase over time as the new components come on stream. The Applicant expected that annual costs would increase from $57.7 million in 2010 to $111 million in 2020 and would eventually increase to $156.2 million annually when the Project was fully operational (targeted for 2035). Overall, the Applicant estimated that 70 percent of the Project operating costs would be used for labour, supplies and services purchased in the RMWB.

Using economic multipliers for the Alberta Non-metallic Minerals Products Manufacturing Industry and the Mining Industry (based on Alberta Finance's Economic Multipliers 2001) the Applicant claimed that the Project would produce, on average, about $104 million in Gross Domestic Product (GDP) for the Province annually during the period 2015 to 2035. During this same period the Applicant claimed that the Project would produce 750 direct, indirect and induced jobs generating a total annual labour income of about $67 million.

Hammerstone stated that within the RMWB, Project operations would annually generate 555 direct, indirect and induced person-years of employment by 2020 and in the opinion of the Applicant this would all be new employment because the regional workforce is expected to remain fully employed. Hammerstone concluded that even though the addition of this new employment is considered insignificant compared to total regional employment, the potential addition of 555 workers and their families could further strain housing, services and infrastructure in Fort McMurray. It is the Applicant's view that the need for expanding facilities in the region applies to all proposed development, not just Hammerstone, and that the Athabasca Regional Issues Working Group (RIWG), in seeking provincial funding for facilities expansion, has factored the demands for oil sands-related development, such as the Project's quarry and limestone processing facilities, into its projections of regional development. The Applicant committed to continuing to work as a member of RIWG to ensure that regional development issues are appropriately addressed.

The Applicant stated that the need for expanding housing, infrastructure and services in Fort McMurray and surrounding communities is well documented and that plans are underway to expand infrastructure and services to accommodate the future demands of oil sands operations and associated industrial and commercial expansion. The Applicant cited a 2005 study by the RIWG that calls for the creation of 6,000 new housing units along with the necessary infrastructure and services to support an estimated population in Fort McMurray of 80,000 by 2010. The Applicant concluded that from the perspective of cumulative economic development in the region, the effect of the Project's operations on population, housing, infrastructure and services can be characterized as long term but insignificant in the context of overall development in the RMWB.

The Applicant stated that given the rapid pace of economic development in the region, it would be very difficult to attribute social problems in Fort McKay and Fort McMurray to any one specific operation. Hammerstone maintained that it is likely beyond its capability to act alone to identify or correct any problems that could be attributed to the Project. However, by becoming a member of, and working with, the RIWG since 2003 the Applicant stated that this indicated its willingness to work cooperatively with other regional businesses and agencies to address problems of regional and local concern.

Hammerstone stated that it expects that the bulk of on-going maintenance would be performed by local building trades workers, depending on demand for these workers. The Applicant also stated that there would be summer job opportunities for regional students. Hammerstone indicated that it would work with regional communities and educators to provide training and employment opportunities to attract regional residents, including Aboriginal youth.

The Applicant made a commitment to provide employment opportunities to regional residents and outlined a three-point plan to assist residents in this regard. Hammerstone stated that it:

- would work with communities and educators to ready aboriginal youth for employment opportunities;
- would work with training and development organizations to develop training programs that would qualify employees to progress into higher skilled jobs and into supervisory jobs; and,
- was prepared to hire from Fort Chipewyan and other outlying communities on a rotational or seasonal basis and provide worker transport in and out of camp accommodation for their time at work.

Hammerstone stated that it had a history of providing significant opportunities to local and Aboriginal businesses. The Applicant stated that during the construction of the MVQ it contracted with Noramac Ventures Inc. (a joint venture company between the Fort McKay First Nation and North American Construction Group). In connection with the operation of the MVQ, the Applicant indicated that it had contracted with a local provider of crushing and screening services, Stony Valley Contracting Ltd.

The Applicant maintained that it and its construction contractors would make every attempt to break down construction work packages, such that local and aboriginal companies had the capability to bid on construction work. Hammerstone expected that regional businesses, provided that they were cost competitive, would be contracted to provide various supplies and services to the Project. Such services would include employee transportation, truck services, water and waste services, janitorial services, mechanical shop services and welding services.

The Applicant stated that limestone products from the Project would be marketed through Hammerstone Products Ltd. (a joint venture with the Fort McKay First Nation) which would receive a royalty and sales fee for every tonne of limestone product sold. Based on projected quarry operations the Applicant estimated that Fort McKay First Nation would earn fees from the Project in the range of $700,000 to $900,000 during the first year of operations, increasing to in excess of $2 million after 2035. Over the Project's life the Applicant claimed that the Fort McKay First Nation would receive in excess of $35 million from the marketing of products produced at the site.

Using current assessment rates Hammerstone calculated that the Project would generate municipal tax revenues in the order of $3 million per year by 2011 and would increase as additional components of the Project came on stream. According to the Applicant municipal taxes from the Project could ultimately increase to in excess of $5 million per year.

The Applicant stated that the Province would be paid a royalty of $0.0441 per tonne of materials quarried from the Project resulting in annual royalties in the $200,000 to $300,000 range during the initial years of operations increasing to $450,000 per annum by 2035. The Applicant estimated that over the life of the Project total royalties paid to the Province would be about $32 million.

The Applicant estimated that the Province would receive personal income taxes on the order of $2.2 million in 2010 increasing to $4.8 million as the Project moved toward full operations.

7.2: Views of the Panel

The Panel concludes that the methodology used by Hammerstone to study the socio-economic impacts of the Project is appropriate.

The Panel notes that the Project will provide a variety of benefits to the Municipality of Wood Buffalo and the province. The Panel sees a benefit to having a limestone processing facility in the Fort McMurray region that is able to provide a less expensive source of building materials to support the development of oil sands plants in the area. The Project will also contribute to job opportunities for local residents during construction and operation, and local businesses will benefit by being called upon to provide various goods and services required for construction and operation of the Project.

The Panel finds an environmental benefit in having a local ability to receive spent lime from oil sands water treatment plants for recycling in the Project's flash calciner to produce regenerated lime. The Panel also notes that the Project meets a local need to manage large amounts of flue gas desulphurization (FGD) solids produced by the reaction of limestone or lime with sulphur-bearing gases at oil sands plants in the region.

The Panel acknowledges that the Project will contribute to socio-economic issues in the region such as housing, education, and health care. The Panel notes that socio-economic strains have leveled off in recent years but are expected to increase again with the expansion of existing oil sands projects and introduction of new ones. The Panel recommends that Hammerstone continue to work as a member of Athabasca Regional Working Group to ensure regional development issues are appropriately addressed.

The Panel notes that Birch Mountain Resources Ltd. entered into an agreement with the Community of Fort McKay on July 29, 2008 that sets out the relationship and long-term commitment of both parties to work together in the Project development. The agreement contains a sub-agreement that describes socio-economic objectives relating to community consultation, education and training, employment, business and economic development, culture, recreation, and community development and infrastructure. The Panel is supportive of the socio-economic commitments made by Hammerstone in the agreement.

SECTION 8: HISTORICAL RESOURCES

8.1: Views of the Applicant

Hammerstone explained that in Alberta, historical resources are defined by the *Alberta Historical Resources Act* to include natural or cultural works that are of value for archaeological, paleontological, historic, scientific, or aesthetic interest. It said archaeological resources are objects, structures, or groups of objects, created by people, and which are or were buried or submerged.

Hammerstone further explained that archaeological resources are divided into two major chronological categories: Precontact, which is material of Aboriginal manufacture dating to before the time of Europeans in Alberta, and Postcontact, which is any material dating to a more recent past. It explained that the Precontact Period is further divided into Early Precontact (before 7,500 years before present), Middle Precontact (7,500 to 1,200 years before present), and Late Precontact (1,200 to about 300 years before present).

Hammerstone said it conducted its Human Resources Impact Assessment (HRIA) under a permit issued by the Archaeological Survey of Alberta (ASA), part of the Historical Resources Management Branch of Alberta Community Development (ACD)(now, Alberta Culture and Community Spirit). It said that field work for the HRIA was conducted between June 29th and August 20th of 2004 and that post-field analysis of collected data is complete and was received by ACD on December 7, 2005.

Hammerstone explained that ACD was in the process of reviewing the HRIA report and would evaluate the results and recommendations of the study. It said that mitigation of archaeological sites indentified in the HRIA would be determined by ACD and would be conducted as a subsequent investigation.

Hammerstone explained that the most important issue in a historical resources assessment is not necessarily the preservation of individual historical or archaeological sites, but rather, the preservation of archaeological knowledge within a region. It said that some historical resources, such as the Quarry of the Ancestors, located adjacent to and to the northeast of the Muskeg Valley Quarry Project, are large and significant enough to necessitate preservation *in situ*. Hammerstone said the Quarry of the Ancestors site is considered to be very highly significant, that its sheer size makes representative sampling impossible, and the archaeological record is best served through preservation.

Hammerstone further explained that sites that represent occupations different from an existing general regional pattern are also very significant. It said that sites that are considered to be of moderate significance are small to medium sized sites, known to contain artifacts that might assist chronological or cultural designation and are more manageable for sampling. For such sites mitigative excavation could reveal useful interpretive data.

Hammerstone explained that determination of the significance of historical sites was the most important and complex evaluation in the HRIA process and was based on site location, size, age, and internal site structure. It said that the field archaeologists conducting the HRIA assigned a level of significance for individual sites and this assessment was then reviewed by ACD, who assigned an HRV (Historical Resource Value) to the site. Hammerstone said the HRV system comprised a six-level system that included Designated

Provincial Historic Resources (HRV1), Registered Historic Resources (HRV2),Significant Historic Resources (HRV3), resources that required further investigation (HRV4), and high potential lands (HRV5). It said historic resources of limited significance were assigned an HRV of 0.

Hammerstone defined the archaeological study area for the Project as the TLSA used for the assessment of Project effects on other terrestrial components. It defined the TRSA as all of the drainage area of the Muskeg River, and portions of the Fort Hills. It said the TRSA included 654 known archaeological sites to March, 2006, and that information derived from analysis of artifacts at these sites provided the regional context in which information gained from sites found in the Hammerstone area might be compared and evaluated.

Hammerstone said it conducted a review of existing information by conducting a historical resource file search for the entire oil sands region prior to its analysis of the archaeological potential in the Project area. It said this assisted in understanding the nature of site locations in similar environments.

Hammerstone conducted an analysis of black and white aerial photos (at a scale of 1:10,000) and colour photos (at a scale of 1:14,000) to determine the likelihood of archaeological sites occurring in the Project area. It based its determinations on previous work in the oil sands region which had established that archaeological sites were associated with higher landforms in the area, and that these landforms were more commonly vegetated by aspen and pine forests, rather that spruce.

Hammerstone explained that its air-photo analysis was followed by field visits to confirm landforms that were well defined and elevated, and by shovel prospecting and more detailed surface survey of those landforms that were elevated.

Hammerstone said its shovel prospecting was conducted by excavating small shovel holes at regular intervals on landforms identified in the air-photo analysis as potentially containing archaeological sites. It described the shovel test holes as being about 40 to 60 cm wide and typically 30 cm deep.

Shovel tests were performed along edges of landforms that were relatively well defined and were generally excavated every 5 to 10 m. Hammerstone said that on long linear transects, such as swamp edges, intervals of 10 m were generally used between shovel prospects, but that interval lengths were decreased in parts of the landforms that appeared more likely to contain sites. Hammerstone also said that smaller intervals were commonly used on smaller, amorphously shaped landforms, and that transects of test holes were run along the edges as well as the tops of such elevated areas. Hammerstone said shovel tests were also performed on transects along every major natural or cultural feature such as a drainage, road or cutline that divided every landform or part of a landform.

Hammerstone said it also examined areas of surface disturbance caused by previous deforestation, vehicle traffic, and construction activities unrelated to the Hammerstone Project. This was done using foot traverses and additional shovel prospecting in areas where this was deemed to be warranted.

Hammerstone reported that 48 archaeological sites had been recorded in the Project area prior to surveys conducted for the Hammerstone and Muskeg Valley Quarry development area.

Hammerstone identified a total of 69 new target areas in the Project area and conducted 3,130 shovel tests in those areas. This resulted in the recording of 39 new archaeological sites in the Project area. An additional 10 sites had been previously observed in the Muskeg Valley Quarry survey on the east side of the Project area.

Of the 39 new sites, one Postcontact encampment and 38 Precontact sites were discovered. Hammerstone said the latter group includes five isolated finds, 12 lithic scatters of undetermined functions, 19 workshop/campsites, one workshop only, and one campsite only. The sites were identified from 112 positive shovel prospects and contained a total of 686 flakes and 98 toois.

Hammerstone explained that the results of its survey indicated that the distribution of archaeological sites in the Project area is governed mainly by topography. It said no sites were recorded in wetlands and only rarely in areas characterized by hilly, shallowly buried outcrops of limestone. Hammerstone said the density of sites is highest in the east part of the Project area where limestone does not outcrop close to the surface and surficial sediments consist of Quaternary sands overlying Cretaceous oil sands.

Hammerstone explained that the majority of the sites within the Project area and within the oil sands region are remarkable because they indicate a heavy reliance on a single tool stone. This rock is now known as the Muskeg Valley Microquartzite (MVMq) and is a hard silica-cemented material that is part of the McMurray Formation. Hammerstone said the MVMq is known to crop out in at least two locations in the northern part of the Project area. It said the two outcrops and associate quarry sites are highly significant archaeological resources and are presently protected as part of the Quarry of the Ancestors area designated as a Protective Notation[26] by ACD.

Hammerstone said that the new sites recorded in the Project area are generally small campsites and workshops representing small camps of highly mobile groups of people, but a few sites are larger and likely indicate locations of longer-term camps. One of those sites, designated as HqOv-107, contains a variety of tool stones other than MVMq. Hammerstone said this site is similar to another site found in the oil sands region that was interpreted as representing the earliest occupations of the region.

With respect to site significance, Hammerstone explained that of the 645 sites that have been recorded to date in the regional study area only one has been designated as a Provincial Historic Resource, but three others, including one in the Hammerstone Project area are considered to be of highest significance. Thirty-five sites are considered to be of high significance, 222 of moderate significance and 362 are of limited significance.

Hammerstone said that only two sites in the entire oil sands region, and only one of the 645 in the regional study area, are permanently protected as Provincial Historic Resources. It explained that a Protective Notation is in place for the group of 11 sites that constitute the

---

[26] Within the Reservation/Notation program administered by Alberta Sustainable Resource Development a Protective Notation (PNT) imposes a land use restriction on crown lands, usually due to specific natural features of the land, but also for historic resources. Generally, a PNT for historic resources serves to recognize the significance of a historic resource and to protect the resource for a specified or indefinite period. A PNT for historic resources is placed by Alberta Culture and Community Spirit with the agreement of SRD and Alberta Energy and represents a commitment to protect the historic resource. (Adapted from 2006 *Public Lands Reservation Information Guide*, Alberta Sustainable Resource Development, 90 pages).

Quarry of the Ancestors in the Project area, which is being considered for designation as a Provincial Historic Resource.

Hammerstone explained that most sites discovered in the Project area are small when compared to other sites in the regional study area, but a few have a high degree of significance relative to the overall knowledge and interpretation of the Precontact history of northeastern Alberta. Hammerstone considered 2 of the 39 sites recorded in the Project area to be of unknown significance, 18 of limited significance, 11 of moderate significance, 8 of high significance, and one of very high significance.

Hammerstone recognized that developments associated with the Hammerstone project would directly and negatively impact the archaeological sites within the Project area. It said all of the sites identified, except two that were located within the 200 m buffer zone along the Muskeg River, would be affected in this manner. Hammerstone said that, in order to prevent the permanent loss of site information, it recommended that Phase I mitigative excavations be performed at all sites of moderate and high significance prior to quarry development. It said that a second phase of mitigative measures (Phase II excavation) might be required after interpretation of Phase I information was complete.

8.2: Views of the Panel

The Panel acknowledges the high level of professional quality apparent in Hammerstone's HRIA and its important role in advancing the current archaeological knowledge in the Athabasca oilsands region. The Panel is of the view that the HRIA demonstrates Hammerstone's very positive attitude toward the need for preservation of the knowledge represented by archaeological sites found during its investigation, and its adherence to requirements of the *Alberta Historical Resources Act*.

The Panel notes, however, that while the HRIA represents a very important part in the overall process of preservation of archaeological knowledge in the Project area, it is only the first step in a more comprehensive process. This overall process is driven by the *Alberta Historical Resources Act* and Alberta Culture and Community Spirit, which administers the Act for the people of Alberta.

While Hammerstone has provided a highly valuable information base, it is now the responsibility of ACD to determine if the information provided, and mitigative measures recommended, by Hammerstone are adequate for the Department to recommend further work as it may deem necessary.

The Panel urges Hammerstone to continue its cooperation with ACD and its compliance with the *Alberta Historical Resources Act* to ensure that the enhanced archaeological knowledge resulting from appropriate site mitigation will be identified and preserved in the public interest of all Albertans.

SECTION 9: PANEL DECISION

9.1: Decision

In undertaking its review of the Hammerstone Corporation application to the NRCB to construct and operate the Hammerstone Project, the Panel has carefully reviewed all written material provided by Hammerstone Corporation, including the environmental impact assessment (EIA), responses to supplemental information requests and answers to Panel questions. Based on its assessment of the information before it and having regard for the commitments made by Hammerstone and subject to the conditions outlined in this decision report, the Panel concludes that the Project is in the public interest.

The Panel has also examined NRCB Approval NR-2005-1 (June 2005) granted to Birch Mountain Resources Limited (now Hammerstone Corporation) for the Muskeg Valley Quarry (MVQ). As Hammerstone intends to operate the Hammerstone Project and the MVQ as a single integrated operation, the Panel has considered the seven conditions attached to the NRCB MVQ Approval to determine whether any of the MQV conditions will continue to apply to the consolidated operation and whether there are any incongruities between the MVQ conditions and the Hammerstone commitments and Board conditions regarding the Hammerstone Project. Based on this consideration, the Panel has reached the following conclusions on how Alberta Environment (AENV) should integrate the NRCB MVQ conditions with the Hammerstone conditions in this report:

- MVQ condition 7 (modeling to predict sound levels) has been fully met; accordingly, condition 7 need not be included in any future AENV integrated approval applicable to the MVQ and Hammerstone Project.
- Condition 2 (particulate air quality monitoring program) has been partially met, to the extent that the prescribed monitoring program for particulate matter has been approved by AENV. Nevertheless, Hammerstone will be expected to continue to implement the monitoring program according to condition 2 in the MVQ Approval and the new, broader condition 3 in this Approval concerning ambient and stack emissions air monitoring.
- Two MVQ conditions have been revised in the Hammerstone Approval, numbers 4 (reclamation plan update) and 6 (noise monitoring and mitigation); these new Hammerstone conditions take precedence over the MVQ conditions.
- The remaining MVQ conditions, numbers 1 (MVQ project approval), 3 (release of water from the quarry settling pond sump) and 5 (rare plant surveys) continue to apply to the MVQ and conditions 3 and 5 extend to the Hammerstone Project and have been incorporated into the NRCB Form of Approval in Appendix A.

9.2: Overview

Section 2 of the *Natural Resources Conservation Board Act* establishes the Panel's mandate, which is to determine whether the proposed Hammerstone Project is in the public interest, having regard to its social and economic effects and the effect of the Project on the environment. The Board does not have a fixed formula for determining whether a reviewable project is in the public interest. To a large extent, the result of any Panel review will be shaped by the nature of the project under review, its location, economic benefits, community support for the project, the project's impact on the natural environment and human health, and the extent of existing developments in the area.

Nevertheless, under its statutory mandate, the Panel must have regard for and balance the economic, social and environmental effects of a proposed project. At minimum, to be approved, a project subject to NRCB review must provide an economic benefit to the people of the Province of Alberta. In most cases, the project will also provide an economic benefit to the proponent, although in instances where the project is put forward by a government department or agency, this may not be the case. As well, the Panel must be convinced that a proposed project will not result in serious harm to the social fabric of the community, the natural environment or the health of members of the public affected by the project.

In evaluating the social and environmental impacts of a proposed project, the Panel understands that it is unlikely that a reviewable project will have no impact on the community or natural environment. The challenge for the Panel in any specific case is to determine whether a proposed project will result in negative impacts that are unacceptable. To ascertain and evaluate potential negative social and environmental impacts of a proposed project, the Panel will consider the scope, quality and reliability of information submitted by the proponent predicting these effects, the risk of a negative effect occurring, preventative measures proposed by the applicant, planned mitigation measures, compliance with current regulations and standards, and follow-up surveillance and monitoring. Through a consideration of these factors, the Panel will make a determination as to whether the predicted impacts are acceptable. If warranted, the Panel will attach conditions to its approval to ensure that necessary steps are taken to protect the community and the environment.

The NRCB views the commitments made by an applicant in its written application as obligations that survive the approval process, independent of their inclusion as conditions to an approval. The Panel is cognizant that its legislated mandate is primarily limited to a one-time determination of whether to grant an approval. Unlike an industry regulator that has the ability to revisit and modify the terms of an approval in response to operational experience and changing technology, NRCB approvals are not easily amended and are binding on successors. In order to respond to this situation, the Panel believes that a pragmatic approach is sometimes required when assessing the ongoing compliance of an approval holder. While the starting point in this assessment may well be a simple question of whether the approval holder is fulfilling commitments made during the course of the application process, the Panel does not believe that blind servitude to commitments that are no longer relevant and beg revision serves the public interest. Rather, the Panel views its responsibility to identify the objectives associated with the proponent's key commitments in its decision report so that, should there be a future need to assess compliance, the integrity of the decision can be preserved.

9.3: Rationale

The Panel agrees that there is a need for aggregate, reagent limestone, quicklime and cement in the oil sands region of the province. The Panel also recognizes the value of the products from the Hammerstone limestone processing facilities in improving the environmental performance of neighbouring developments; specifically, the use of reagent limestone for desulphurization of flue gas in oil sands operations, the use of quicklime for emission control systems to remove sulphur dioxide and sulphur trioxide in bitumen upgrader plants and in the water purification systems of municipal and industrial facilities and the use of hydrated lime in the production of boiler feed water at the *in situ* oil sands projects. The Panel further acknowledges the environmental benefits of Hammerstone's plan to construct a recalcining system to process the by-product spent lime from oil sands operations in the region.

The Panel is satisfied that the proposed Hammerstone project constitutes a viable endeavour and that it will contribute to the economic well-being of the Regional Municipality of Wood Buffalo and the Province of Alberta as a whole. The Project will create jobs for local residents during construction and operation and local businesses will benefit through the provision of various goods and services required by the Project. The Province will benefit from royalties and personal income taxes. While the Project might exacerbate regional socio-economic challenges in the areas of housing, education and health care in a relatively minor way, the Panel is satisfied with Hammerstone's commitment to work as a member of the Athabasca Regional Working Group to address regional development issues. In summary, the Hammerstone project will provide both the region and the province as a whole with economic benefits and environmental benefits through the use of its products.

A key issue for the Panel in this review is the viability of the conceptual conservation and reclamation plan (C&R) proposed by Hammerstone. The C&R is of particular concern to the Panel for three reasons: one, the uniqueness and complexity of the proposed C&R, two, the lengthy time period before the C&R will be completed, and three, the many uncertainties around the C&R and factors that might cause it to change over the years, including the evolution of reclamation best practices, the extent of industrial and other development in the oil sands area and changes to relevant regulatory requirements. The Panel notes that the C&R has already changed in a significant way during the course of NRCB consideration of the Hammerstone Project application, evolving from a deep quarry lake to a shallow quarry lake, due to the terms of an approval issued for an adjacent oil sands development. This change has implications for many aspects of project planning and environmental mitigation and will require reconsideration of many elements of the original reclamation plan.

Accordingly, to address these uncertainties, the NRCB's approval of this project is subject to a condition that the Hammerstone C&R be updated and submitted to Alberta Environment every 5 years, rather than the usual regulatory requirement of 10 years. While this condition is already a requirement of the NRCB MVQ approval and AENV's MVQ EPEA approval, this approval also lists a number of matters that must be either included in the 5 year C&R update for assessment by AENV, or reported to AENV in conjunction with the 5 year update. These matters include for example: updates on the filling period and volume of water required for the lake; predictions of surface water quality in the quarry lake; mitigation measures for impacts to soils; revegetation using the best available knowledge and techniques; coordination of the wildlife monitoring program; and the viability of a recreational fishery in the quarry lake. While Hammerstone cannot be expected to accurately predict the future, it can be called upon to carefully consider and update on a regular basis, its plans to reclaim the Hammerstone mine site.

A second key issue for the Panel in considering the Hammerstone application arises from the relative impact of the Project on the community and natural environment in the oil sands region of Alberta. The Panel acknowledges that Hammerstone is a relatively small contributor to the environmental and social challenges in the oil sands area. While in the Panel's view, Hammerstone cannot be held solely or even significantly responsible for anticipated problems, it also cannot be absolved from contributing to efforts to find solutions to those problems. The Panel is aware that government, industry, citizen and Aboriginal stakeholders have formed a number of organizations intended to address environmental and social issues on a regional basis. Accordingly, throughout this decision report, Hammerstone is required to actively participate on committees and associations working to resolve regional environmental and social issues and to report to Alberta Environment annually on its activities. Throughout this decision, the Panel has referred to Hammerstone's participation on generic "regional committees and associations" although some such as the Wood Buffalo Environmental Association (WBEA) and Cumulative Effects Management Association (CEMA) are well known, in recognition of the inevitable evolution of specific decision-making and consultation processes over the lifetime of the Project.

The Panel looks forward to the results of the provincially mandated regional planning processes currently underway which are expected to address the cumulative environmental impacts of developments in the oil sands region of Alberta, which has been a major focus of this NRCB decision.

At numerous points in this decision report, the Panel has noted instances where it is satisfied with Hammerstone's commitments to adopt various forms of preventative measures and mitigation to minimize the impact of the Project on the community and the environment. Nevertheless, to supplement those commitments, the Panel has imposed conditions on Hammerstone regarding additional steps needed to ensure that the Project meets Alberta's needs. These conditions include measures to adopt specified design requirements, to undertake monitoring, to redo various analyses and assessments that were not adequately completed as part of the EIA process, to develop management plans and to engage in continuing communication and consultation with Aboriginal peoples and others affected by the Project.

Due to the very nature of the proposed Hammerstone Project, which involves a large surface disturbance, the Panel acknowledges that there will be some irreversible impacts to the community and the natural environment, despite the Applicant's commitments regarding prevention and mitigation and the Panel's conditions. Nevertheless, the Panel concludes that the Project is in the public interest based on the expected benefits from the Project, and the careful project planning undertaken by Hammerstone.

DATED at the Calgary, Alberta, this 28th day of June, 2010.

Original signed by:

Vern Hartwell, Panel Chair

Jim Turner

Donna Tingley

APPENDIX A: NRCB FORM OF APPROVAL

THE PROVINCE OF ALBERTA
NATURAL RESOURCES CONSERVATION BOARD ACT
NATURAL RESOURCES CONSERVATION BOARD

IN THE MATTER of a project of Hammerstone Corporation for approval to construct and operate a limestone quarry and aggregate, reagent limestone, quicklime, spent lime reprocessing, and cement production facilities near Fort McKay, Alberta

APPROVAL NO. NR 2010-01

WHEREAS the construction and operation of a metallic or industrial mineral project is a reviewable project under s. 4(c) of the Natural Resources Conservation Board Act, and

WHEREAS by Order in Council 171/2005 the Lieutenant Governor in Council, on the recommendation of the Minister of Environment, pursuant to section 4(f) of the Natural Resources Conservation Board Act, prescribed as a reviewable project the quicklime plant proposed by Birch Mountain Resources Ltd. as a reviewable project within the meaning of the NRCBA; and

WHEREAS the Natural Resources Conservation Board is prepared to grant approval to the application by Hammerstone Corporation, subject to the conditions herein contained, and the Lieutenant Governor in Council has given authorization, hereto attached.

THEREFORE, the Natural Resources Conservation Board hereby orders as follows:

1. The project of Hammerstone Corporation, for construction and operation of a limestone quarry and aggregate, reagent limestone, quicklime, spent lime reprocessing, and cement production facilities near Fort McKay, Alberta, as described in Application No. 0601, from Hammerstone Corporation to the Board filed May 24, 2006 and all supplemental material supporting the Application filed with the Natural Resources Conservation Board, is approved, subject to the undertakings and commitments in the application and the terms and conditions herein contained.

2. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, incorporate the BATEA (best available technology economically achievable) in final designs to mitigate air emissions as each plant is brought online.

3. Hammerstone Corporation shall conduct ambient air and stack emission monitoring in a manner satisfactory to Alberta Environment.

4. Hammerstone Corporation shall, to the satisfaction of Alberta Environment:

   a) adopt and adhere to the requirements of the current ERCB noise directive;

   b) implement a variety of operational noise reduction measures such as mufflers, silencers and shielding, road maintenance, and traffic routing;

   c) implement a routine noise monitoring program through the life of the quarry and in cooperation with and input from local stakeholders and community residents; and,

   d) apply further mitigative measures, if exceedances of permissible sound levels are detected by the monitoring at the Trapper's Cabin or other representative location.

5. Hammerstone Corporation shall ensure that the groundwater drainage features that will direct groundwater around the FGD and spent lime storage areas are designed and constructed to Alberta Environment's satisfaction.

6. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, resample and analyze groundwater from all monitoring wells that have not been removed by quarrying to date. The Applicant must follow established protocols and procedures for sampling, handling, and analysis of the water samples for dissolved metals concentrations. Analytical results and a description of protocols used to obtain those results must be submitted to Alberta Environment before issuance of the EPEA approval.

7. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, monitor for nitrogen and phosphorus within the quarry water storage pond (settling pond) prior to and during water releases. Condition 3 from the MVQ approval (NR 2005-1) continues to apply, specifying other constituents to be monitored.

8. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, implement appropriate mitigation measures into a surface water management plan. The surface water management plan must include implementation of a surface water quality monitoring program for potentially impacted locations within the ALSA and ARSA, including locations along the Muskeg River both up- and downstream of the Project, as done for the Muskeg Valley Quarry.

9. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, complete and present a reassessment of soil resources in response to the latest C&R that now involves a shallow quarry lake.

10. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, as part of the reclamation process ensure the placement of a 50 cm depth of topsoil cover to ensure the establishment of self-sustaining upland forest ecosystem in a setting where soil moisture is likely to become a critical factor for long-term success.

11. Hammerstone Corporation must conduct rare plant surveys and provide the results of such work to Alberta Environment in advance of each mine phase.

12. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, design and construct the landform to allow for easy animal access to the quarry lake.

13. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, establish and maintain throughout the period of quarry operations, a 200 m setback between the Muskeg River and the Project boundary to prevent any direct loss or alteration of fish habitat in the Muskeg River.

14. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, adopt standardized wildlife monitoring methods such as those that have been adopted in the Alberta Biodiversity Monitoring Program.

15. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, monitor the success of the habitat enhancement structures, increase their number if proven successful, and if found to be ineffective, look at other habitat enhancement measures.

16. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, prepare a document entitled "*Gypsum Landform Design Plan and Specifications*" prior to construction of the landform. The Panel requires this plan to be based upon actual site evaluation data and the results of site-specific groundwater and geochemical modeling, using the characterization data from a statistically relevant number of samples of FGD/FBC and spent lime waste materials from various regional sources.

17. Hammerstone Corporation shall, to the satisfaction of Alberta Environment, update the reclamation plan for the Project every 5 years and submit this to AENV. This update shall include:

    a) updates on the quarry lake filling period and volume of water required for the reclamation objective;

    b) a review of surface water quality estimations and predictions of the quarry lake;

    c) monitoring of surface water quality during and following the lake-filling period to validate predictions and provide guidance to changes in reclamation activities as required;

    d) an assessment and documentation of any changes to the mitigation measures for Project impacts to soil resources;

    e) monitoring and assessment of wetland reclamation success during reclamation activities and a residual vegetation and wetland impact assessment;

    f) the revegetation portion of the reclamation plan using the best available knowledge and techniques developed over time; and

    g) any relevant outcomes that have been developed through consultation with affected stakeholders and any significant advances in the technology and knowledge of land reclamation in the region.

18. Hammerstone Corporation shall conduct the following at the time of the reclamation plan review every five years and report its findings to Alberta Environment:

a) provide information on how the Project wildlife monitoring program coordinates with the reclamation plan to gain a better understanding of the residual impacts of the Project on wildlife; and

b) investigate and resolve the uncertainties that exist concerning a sustainable fishery and present a revised quarry lake plan based on these findings.

19. Hammerstone Corporation shall actively contribute to regional committees and associations:

a) addressing air quality issues, with the goal of achieving reductions in air emissions;

b) associated with surface water issues and hydrology related initiatives;

c) working to understand the impacts of acidification and to reduce PAI emissions, particularly in regional areas where critical loads have been exceeded;

d) working to understand and minimize the impacts to vegetation and wetlands;

e) working toward regional solutions to human health issues, including any future human health exposure studies;

and provide an annual report of such activities to Alberta Environment.

Made at the City of Calgary, in the Province of Alberta, this ____ day of __________, 2010.

NATURAL RESOURCES CONSERVATION BOARD

____
Vern Hartwell, Panel Chair

____
Jim Turner

____
Donna Tingley

APPENDIX B: ACRONYMS AND ABBREVIATIONS

AAAQG	Alberta Ambient Air Quality Guidelines
AAAQO	Alberta Ambient Air Quality Objectives
ACD	Alberta Community Development (now Alberta Culture and Community Spirit)
ACFN	Athabasca Chipewyan First Nation
AENV	Alberta Environment
AEPEA	*Alberta Environmental Protection and Enhancement Act*
ALSA	aquatic local study area
AQLSA	air quality local study area
AQRSA	air quality regional study area
ARSA	aquatic regional study area
ASA	Archaeological Survey of Alberta
ATSDR	Agency for Toxic Substances and Disease Registry
AWI	Alberta Wetland Inventory
BATEA	Best Available Technology Economically Achievable
BMR	Birch Mountain Resources Ltd.
Board	Natural Resources Conservation Board
BSL	basic sound level
C&R	Conceptual Conservation and Reclamation Plan
CaO	calcium oxide (quicklime)
CASA	Clean Air Strategic Alliance
$CaSO_4$	calcium sulphate (gypsum)
CEA	cumulative effects assessment
CEMA	Cumulative Effects Management Association
cm	centimetre
CO	carbon monoxide
CO_2	carbon dioxide
CO_2E	carbon dioxide equivalent

COC	chemical of concern
CWQG	Canadian Water Quality Guidelines
CWS	Canada-Wide Standard
DFO	Department of Fisheries and Oceans
EIA	environmental impact assessment
EPA	Environmental Protection Agency
EPEA	*Environmental Protection and Enhancement Act*
ERCB	Energy Resources Conservation Board
ESA	environmentally significant area
EUB	Energy and Utilities Board
FBC	fluidized bed combustion
FGD	flue gas desulphurization
FMFN	Fort McKay First Nation
FMU	forest management unit
GDP	gross domestic product
GHG	greenhouse gas
GPS	groundwater performance standards
H_2S	hydrogen sulphide
ha	hectare
HADD	harmful alteration, disruption or destruction
HHRA	human health risk assessment
HQ	hazard quotient
HRIA	Historical Resources Impact Assessment
HRV	Historical Resource Value
HSI	Habitat Suitability Index
ILCR	incremental lifetime cancer risk
IRC	Industry Relations Corporation
IRIS	Integrated Risk Information System
ISC	Industrial Source Complex Model

km	kilometre
LCC	Land Capability Class for Forest Ecosystem in the Oil Sands
LCP	Least Cost Path
Leq	Energy Equivalent Sound Level
LL	lower lifts
LSA	local study area
$\mu g/m^3$	microgram per cubic metre
m	metre
MCFN	Mikisew Cree First Nation
ML 1935	Métis Nation of Alberta Local 1935
MOU	Memorandum of Understanding
MPOI	maximum point of impact
MVQ	Muskeg Valley Quarry
NIA	noise impact assessment
NO_x	nitrogen oxides
NRCB	Natural Resources Conservation Board
NRCBA	*Natural Resources Conservation Board Act*
PAHs	polycyclic aromatic hydrocarbons
PAI	potential acid input
PFC	pneumatic flash calciner
PM	particulate matter (eg. PM_{10} depicts particles of 10 micrometres or less)
ppm	parts per million
Project	project proposed by Hammerstone Corporation
PSLs	permissible sound levels
RAMP	Regional Aquatic Monitoring Program
RIVM	National Institute for Public Health and the Environment
RIWG	Regional Issues Working Group
RMWB	Regional Municipality of Wood Buffalo
RSA	regional study area

SAGD	stream assisted gravity drainage
SCR	selective catalytic reduction
SIR	supplemental information request
SNCR	selective non catalytic reduction
SO_2	sulphur dioxide
SO_3	sulphur trioxide
TCLP	toxicity characteristic leaching protocol
TDS	total dissolved solids
TIA	traffic impact assessment
TEK	traditional ecological knowledge
TLSA	terrestrial local study area
TLU	traditional land use
TRSA	terrestrial regional study area
TRU	traditional resource use
TSP	total suspended particulate
TSS	total suspended solids
UL	upper lifts
VOCs	volatile organic compounds
WBEA	Wood Buffalo Environmental Association
WMU	wildlife management unit

Contact the Natural Resources Conservation Board at the following offices:
Dial 310.0000 to be connected toll free.

Edmonton Office
4th Floor, Sterling Place, 9940 - 106 Street
Edmonton, AB T5K 2N2
T (780) 422.1977 F (780) 427.0607

Calgary Office
3rd Floor, 640 - 5 Avenue S.W.
Calgary, AB T2P 3G4
T (403) 662.3990 F (403) 662.3994

Email: info@nrcb.gov.ab.ca
Web Address: www.nrcb.gov.ab.ca

Copies of the *NRCB Act, Rules of Practice of the Natural Resources Conservation Board Regulation and Administrative Procedures Act* are available through the Queen's Printer. NRCB Guides are available by contacting the NRCB's Edmonton Office.

ISBN 978-0-7785-9200-6

Copyright 2010